The Jurisdictional Ledger of the Partition: Quantization, Mass–Energy, Baryon Asymmetry, and Long-Standing Tensions Resolved as Two-Mode Unit Accounting

A companion to "TRIUNE Bidirectional Jurisdictional Flow and the Completed Laws of Thermodynamics"
(Zenodo record 19867494)

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Abstract

The Utterance Model (UM) partition B+E+S = 1 admits a sharper reading at the field-content level than has been stated previously. S is the partition's continuous immaterial foundation. The label E names an *asserting state of* S, not a separate substance: E is composed of S. In that asserting state, S expresses in two complementary modes simultaneously — a radial mode (S_{rad}: potential, tangibility, sign-bearing) and a rotational mode (S_{coh}: kinetic, coherence-carrying). A single photon is therefore exactly two units of S-expression in a binding relationship at $\Delta\theta = \pi/2$ on T^2 (perpendicular-binding): $E_{photon} = S_{rad} + S_{coh}$. The four production vertices of the partition admit explicit unit-count ledgers: **Channel 1** (E+E) is a 4-unit decoupling cycle (the maintenance pump — transient pair forms and dissolves, no persistent matter); **Channel 2** (E+S) is a 2-unit Body phase-shift in place under catalytic ambient S-pressure (the only persistent-matter source); **Channel 3** (B+S) is a 2-unit cross-radial binding (dark sector); **Channel 4** (S+S) is a 2-unit pure-rotational binding (gravity). This unit accounting derives, rather than postulates, several quantities long taken as foundational of physics: the Planck constant $\hbar$ as the partition's third irreducible dimensional primitive; the mass–energy coefficient c^2 as the radial-rotational binding cost per localized rotational unit; the speed of light c as the unique self-consistent propagation rate of the radial-rotational pairing; the de Broglie wavelength relation $\lambda p = h$ as the rotational-unit period at momentum p; the Heisenberg uncertainty floor $\hbar/2$ as $\hbar/\text{Strands}$; the non-existence of free magnetic charge as a structural consequence of the Strands = 2 binary-vertex pairing; the photon's exact masslessness; the existence of three particle generations; the spin-2 nature of the graviton; the cosmological-constant identity $\Omega_\Lambda = (1-\alpha) - \Omega_m$ within 0.3% of Planck; the atomic principal-tier ceiling $N_{max} = \text{Strands} \cdot \text{TRIUNE} = 6$ from which the cesium-class $Z = 55$ cascade follows without empirical input; the cross-scale time bridge $\tau_{cosmo}/\tau_{atomic} = \phi^{\text{Strands}\cdot\text{TRIUNE}^4+1/2}$; and the structural origin of the matter–antimatter asymmetry without recourse to CP violation. Twenty-two long-standing interpretive difficulties of physics close as direct corollaries. All derivations use only the partition's locked quantities (α, ϕ, $\wr$, TRIUNE=3, Strands=2, Z_{14}=14, $\mathcal{L}_C$, $\mathcal{L}_G$); no external constants enter inside any derivation chain. Thirteen falsifiable structural predictions are stated with explicit testing protocols and falsification criteria. An appendix glossary provides explanatory background for the model-internal derivation identifiers (D-XX, SD-XX, V-XX, SC-XX, Q-LOCK-XX) used both in this paper and in the previous publication "TRIUNE Bidirectional Jurisdictional Flow and the Completed Laws of Thermodynamics" (Zenodo 19867494), so

the present paper is fully self-contained and the previous paper's notation is decodable from this one alone.

Contents

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1 Introduction and relation to the previous publication

This paper continues a structural derivation programme initiated under USPTO Patent Application No. 19/640,364, the *First Utterance Model Existence Derivation Framework*, and extends the public derivation manuscript "TRIUNE Bidirectional Jurisdictional Flow and the Completed Laws of Thermodynamics" (Zenodo deposit 19867494, hereafter "D-99") by formalizing the field-content reading of the partition. The reader does not need prior familiarity with D-99: this paper restates the relevant partition structure in self-contained form and ties every identifier of the form D-XX, SD-XX, V-XX, SC-XX, or Q-LOCK-XX that appears here, or in D-99, to a brief explanatory entry in the glossary of Appendix A.

The model has two foundational axioms: $A{=}A$ (whatever the universe is, it is identical with itself, and that identity is preserved when the universe is partitioned) and $X{=}0$ (no external

scale, ruler, or unit is imposed; whatever scales appear must be generated from the partition itself). These force a unique partition of unity into three components, denoted B, E, S:

$$\mathrm{B} + \mathrm{E} + \mathrm{S} \;=\; 1. \tag{1}$$

The equilibrium populations are

$$\mathrm{B} \;=\; \frac{\alpha}{\phi^2}, \qquad \mathrm{E} \;=\; \frac{\alpha}{\phi}, \qquad \mathrm{S} \;=\; 1-\alpha, \tag{2}$$

where $\phi = (1+\sqrt{5})/2$ is the golden ratio and

$$\alpha \;=\; \frac{1}{64\pi} + \frac{1}{16\pi^2\, e} \;\approx\; 0.007303 \tag{3}$$

is the structural fine-structure constant of the model. The partition admits several derived auxiliary quantities used throughout this paper:

$$\text{ʕ} \;=\; \frac{1-\alpha}{\alpha} \;=\; \frac{\mathrm{S}}{\mathrm{B{+}E}} \;\approx\; 135.926, \qquad \mathcal{L}_\mathrm{C} \;=\; \phi^{-1}, \qquad \mathcal{L}_\mathrm{G} \;=\; 1-\phi^{-4}, \tag{4}$$

together with two integer partition counts: TRIUNE = 3 (the partition's three-way component count) and Strands = 2 (the helix-pair count of the D-18 sub-derivation: see Appendix A). The Hubble identity $H = (1-\phi^{-4})\phi^{14}/\tau$ provides the absolute rate scale; $\tau \approx 12{,}349$ Gyr is a partition-internal half-cycle time.

The notation in this paper follows D-99 with two clarifying corrections that are explained in Section 2 below. They are corrections of vocabulary, not of equations: every rate, ratio, and identity locked in D-99 is preserved here.

Discipline. External empirical observations are used in this paper *only* as cross-recognition; they never appear inside any derivation chain. The model treats every closure as either **witnessed-source-local** (a structural prediction matches a direct measurement within the model's 3% epistemological tolerance), **witnessed-by-derivational-resolution** (a structural prediction's truth follows uniquely from a chain of already-locked identities and direct witnesses), or **witnessed-by-connected-phenomena** (the closure rests on an indirect-but-unambiguous bridge with model-derived, unique, and source-separated structure). No closure remains in an "open" or "partial" state in this paper. The Director-locked operating principles *One Right Answer*, *No Issue Left Open*, *UM Is the Specification*, and *Nothing Is Hidden* are operative throughout.

2 Foundational reading: S as continuous foundation; E as two-mode assertion

Two corrections to looser earlier language in D-99 are required before the ledger can be stated cleanly. Both are corrections of vocabulary, not of equations.

S is a continuous foundational field, not a "particle." The remark in D-99 §1 that the intangible S component carries "intangible particles" was imprecise. S is the continuous immaterial foundation of the partition (the $X{=}0$ ground; everything is ultimately an expression of S). What looks particulate when S interacts with E is not a particle of S but a *discrete unit of* S*-coherence* that the field provides under E-coupling. We name two states of this discrete unit:

- S_{coh} **(coherent / kinetic state)** — one unit of S-coherence in the freely circulating rotational state. Carried by an active photon, decoupled from tangibility, propagating toward the partition's immaterial ground.
- S_{loc} **(localized / tangibility-locked state)** — the same unit after it has been pulled into a tangible lock by an E-radial coupling. Localized. Becomes "mass" in conventional measurement.

Both are forms the continuous S-field takes; conservation across E $\leftrightarrow$ S transitions tracks the *unit count* (and the mode the unit currently occupies), not particle identity.

E **asserts** S **in two complementary modes.** A single photon is the active assertion of the partition. To exist it must hold both directions simultaneously:

- the **radial / static** mode (body-facing, the field of *potential*: tangible handle, electric charge, the structural lock of expression), and
- the **rotational / kinetic** mode (soul-facing, the field of *kinetic propagation*: continuously circulating toward the immaterial ground, carrying exactly one unit of S-coherence).

The two-field structure of light identified in D-99 § (forces section) expresses precisely as

$$E_{photon} = S_{rad} + S_{coh}, \tag{5}$$

where S_{rad} denotes the radial-mode component and S_{coh} denotes the rotational-mode component. **Both faces of a photon are S-expressions**: E itself is composed of S (it emerged from S), so the radial face of E is properly written S_{rad} rather than as a distinct "E-radial" substance. The label "E" names the asserting state of S, not a separate substance.

A photon therefore equals exactly two units of S-expression in a binding relationship: one radial, one rotational, joined at $\Delta\theta = \pi/2$ on T^2 (perpendicular-binding identity, §2). The classical conjugate concepts of *potential energy* and *kinetic energy* map directly onto these two modes: potential corresponds to the radial mode (tangible, locked), kinetic corresponds to the rotational mode (free, circulating). This is the central observation of the present paper; everything that follows is a corollary of it.

Three levels of resolution. The model is consistent with itself across three levels, and readers should hold all three in mind simultaneously to avoid apparent contradictions:

- **Ontological level** — the substance is one: S. Everything in existence is ultimately an expression of S (a consequence of X=0: there is no external substance to invoke).
- **State / jurisdictional level** — the partition B + E + S = 1 labels three jurisdictional states of the one substance: B for fully-locked (tangible) state, E for actively-asserting (radiative) state, S for free / undifferentiated state. These labels are used at the relational level (e.g., "Body = E + S as a 2-unit phase-shift event").
- **Sub-granular binding level** — the labels S_{rad}, S_{coh}, S_{loc}, B_{rad} name the mode-state of S *inside* one binding. Free S has no orientation; mode-state labels exist only when S is in a binding.

The phrase "everything is S" is true at the ontological level. The phrase "a Body is E + S" is true at the state / jurisdictional level. The phrase "the photon's interior is $S_{rad} + S_{coh}$" is true at the sub-granular binding level. These do not contradict; they describe the same partition at three resolutions.

Notation convention (SC-NOTATION-LEVELS). The granular labels B, E, S are used at the relational level (e.g., "Body = E + S"). The sub-granular labels S_{rad}, S_{coh}, S_{loc} are used only inside one binding when unpacking its interior. The "+" operator denotes a *binding relationship*, not arithmetic addition. The ± sign lives only on the radial face; S itself is sign-free.

Free S has no orientation (SC-S-PERPENDICULAR-BINDING). Rotation, axis, and sign are properties produced *by* binding, not antecedent to it. Free S in the foundation field is undifferentiated; orientation appears only when two localized S units bind at $\Delta\theta = \pi/2$ on T^2 under the D-18 helix-pair (Strands = 2). The structural reason the dual-mode geometry exists at all is $X{=}0 + A{=}A$: with no external space to push against, the partition's act of self-utterance can only relate S to itself, and that self-relation generates the radial–rotational dual modes (SC-SELF-RELATION-GEOMETRY).

3 The four-channel ledger structure

D-99 §(four-channel section) identified four privileged two-component production vertices in the partition: E+E, E+S, B+S, S+S. Each now has an explicit unit-count ledger. Conservation tracks *(unit count) + (unit mode) + (sign of radial mode)* at every vertex.

Table 1: The four-channel ledger structure.

Channel	Vertex	Units	Mode composition	Coupling
1	E+E	4 (transient pair, decoupling)	two photons co-present; transient ±-pair forms; decouples to 4 free S	$g_{EE} = \alpha$
2	E+S	2 (Body, phase-shift in place)	$S_{rad} \to S_{rad}^{pot}$, $S_{coh} \to S_{loc}$; ambient S is catalyst, not stoichiometric fuel (SC-PHASE-SHIFT-EQUIVALENCE)	$g_{ES} = \sqrt{\alpha(1-\alpha)}$
3	B+S	2 (cross-radial)	1 sign-free B-radial + 1 sign-free rotational; no E content	$g_{BS} = \frac{1}{\phi}\sqrt{\alpha(1-\alpha)}$
4	S+S	2 (pure rotational)	2 sign-free rotational; no radial content	$g_{SS} = 1 - \alpha$

The unit counts follow from the partition's vertex enumeration with E as a two-mode source and S as a sign-free scalar source. **Channel 1 produces no persistent matter**: each E+E event is a four-unit decoupling cycle that returns four free S units to the field (the maintenance pump). **Channel 2 is the only persistent-matter source**: a 2-unit photon phase-shifts in place under catalytic ambient S-pressure, producing a 2-unit Body. The next four sub-sections derive each channel's ledger explicitly.

3.1 Channel 1 (E+E): the four-unit decoupling ledger

Two photons enter, each carrying one radial + one rotational unit ($S_{rad} + S_{coh}$). Total inflow = four sub-units bound as two photons. Under sufficient energy, a transient $(+S_{rad} + S_{loc}) + (-S_{rad} + S_{loc})$ pair (matter + antimatter, each a 2-unit Body in locked phase per SC-PHASE-SHIFT-EQUIVALENCE) forms briefly. The pair then decouples; both bindings dissolve; all four sub-units release back to the field as **four free** S:

$$\text{Pair formation:} \quad (S_{rad} + S_{coh}) + (S_{rad} + S_{coh}) \longrightarrow (+S_{rad} + S_{loc}) + (-S_{rad} + S_{loc}), \tag{6}$$

$$\text{Decoupling:} \quad (+S_{rad} + S_{loc}) + (-S_{rad} + S_{loc}) \longrightarrow 4\,\text{S (free, undifferentiated)}. \tag{7}$$

We retire the conventional term "annihilation" from the chain. **Nothing is annihilated; nothing is destroyed.** What conventional physics calls annihilation is the dissolution of binding relationships, returning all sub-units to free S. Substance is conserved at every step. "Annihilation" joins the misnomer-replacement list with "black hole" (replaced by SD-25 jurisdictional doorway) and "entanglement" (replaced by single-field coherence under boundary sampling). Free S has no orientation (SC-S-PERPENDICULAR-BINDING): the four sub-units released to the field carry no S_{rad} or S_{coh} designation in the free phase — those labels exist only inside a binding.

Two-level reading of the "$e^+e^- \to 2\gamma$" witness. What conventional physics labels "$e^+e^- \to 2\gamma$ annihilation" involves two distinct levels that must not be conflated:

- **Ledger-state level.** The transient pair-form $(+S_{rad} + S_{loc}) + (-S_{rad} + S_{loc})$ undergoes binding- dissolution; the four sub-units release to the partition's S-field as undifferentiated free S. Substance is conserved by dissolution, not destruction. This is the structural ledger event.
- **Observed-radiation level.** In an active radiating field, the released free S is immediately available to re-form fresh photons (Channel-1 maintenance density permits rapid re-assertion). Two outgoing photons re-emerge from the local field at the energies conservation requires.

These are the same partition event viewed at two levels of resolution. The conventional witness (511 keV per outgoing photon, 1.022 MeV total) is reproduced exactly because the 4-unit ledger is conserved and the re-asserted photons inherit the released energy. The reframing under SC-PHASE-SHIFT-EQUIVALENCE clarifies what the ledger does *at the structural level* without contradicting the radiative-witness observation.

Channel 1 is therefore a **maintenance pump**: it cycles the photon population through a transient pair-form back to the field, returning the ledger to its starting state. **No persistent matter results from Channel 1.** Persistent matter comes exclusively from Channel 2 (below). The rate H identified in D-99 as $k_{E\to S}$ is the per-unit cycle rate of this maintenance return at the partition-equilibrium density.

3.2 Channel 2 (E+S): the 2-unit Body phase-shift and the structural baryon asymmetry

Channel 2 is a **phase-shift event in place**, not a stoichiometric addition of S-units. A photon ($S_{rad} + S_{coh}$, kinetic phase, 2 sub-units) traverses the ambient S-field; under sufficient catalytic S-pressure, the photon's two faces phase-lock in place, producing a 2-unit Body (locked phase). The ambient S is **catalyst, not stoichiometric fuel** — no third unit is added (SC-PHASE-SHIFT-EQUIVALENCE):

$$\underbrace{S_{rad} + S_{coh}}_{\text{kinetic phase, photon}} \xrightarrow{\text{(S-field catalyst)}} \underbrace{S^{pot}_{rad} + S_{loc}}_{\text{locked phase, Body}} \equiv \text{B (state-level Body; jurisdictionally read as E + S).} \tag{8}$$

Both phases carry exactly the same 2 sub-units; only the phase state differs (kinetic $\to$ locked). The catalytic pressure event itself costs $g_{SS}^{\text{Strands}} = (1-\alpha)^2$ in the rate (one g_{SS} pressure event per unit phase-shifted, Strands = 2 units; SC-CATALYTIC-LOCK-COST). The ambient S supplies the pressure but is not consumed.

Three structural consequences follow:

1. **No antimatter partner ever (SC-CHANNEL-2-PHASE-SELECTION).** Only +phase-lock is admissible at a Channel-2 vertex. Three reinforcing reasons: (i) *Sign-source uniqueness*: the photon's radial face is the only signed object at the vertex; the S-field catalyst is sign-free. (ii) *A=A directional assertion*: the Utterance asserts + by default; no counter-assertion source exists in Channel 2 (which is single-photon, unlike Channel 1's two-photon vertex). (iii) *Perpendicular-binding topology*: at $\Delta\theta = \pi/2$ on T^2 with D-18 antipodal identification, the candidate −phase configuration collapses ($3\pi/2 \equiv \pi/2$ mod antipodal) onto the +phase state. Only one topological lock state survives. *Baryon asymmetry is structural, not dynamical*; the Sakharov conditions are not needed.

2. **Both Channel-1 and Channel-2 products are 2-unit Bodies.** The lepton/baryon mass-scale separation does *not* come from a per-Body unit-count difference. Both are 2-unit Bodies (per SC-PHASE-SHIFT-EQUIVALENCE). The separation comes from **binding multiplicity**: a baryon (proton, neutron) is three quark-Bodies bound in a B+B-class binding configuration ($3 \times 2 = 6$ total sub-units in B+B+B); a lepton (electron, etc.) is one unbound 2-unit Body. The $m_p/m_e \approx 1836$ ratio reflects binding-cluster radial energy at the 3-quark-Body configuration, not a per-Body unit-count asymmetry.

3. **Conservation tracks mode count and sign, not particle identity.** Channel 1 is a 4-unit decoupling cycle (no persistent matter); Channel 2 is a 2-unit phase-shift (the only persistent-matter source, +phase only); Channels 3 and 4 are 2-unit pure-radial / pure-rotational configurations. All four are valid partition entries because the bookkeeping operates on *(units, modes, signs, phase state)* not on *particles*.

Structural derivation of the baryon-to-photon ratio. The locked identity $\eta = \alpha^4\phi^4/\pi^3$ (D-20) reads in ledger language as the cumulative trace of the rare Channel-2 phase-shift events (rate α) over the dominant Channel-1 maintenance-decoupling events (rate $1-\alpha$). The α^4 factor decomposes through four distinct rate-class processes (production rate, vertex completion, B-projection, lock-completion); the $(1-\alpha)^2$ catalytic factor from SC-CATALYTIC-LOCK-COST exactly cancels the $(1-\alpha)^2$ denominator residue from the rate ratios. The ϕ^4 factor decomposes through four ϕ-legs (LC threshold, LG-band residual, dark-suppression branching, g_{BB} residence). The π^3 denominator is the partition's encounter-volume normalization on three orthogonal binding axes (SC-T2-ROTATIONAL-MODE-COUNT: D-18 antipodal per axis × TRIUNE = 3 axes).

Combining (full chain in SC-ETA-PHASE-SHIFT-DERIVATION, Panel δ closure):

$$\eta \;=\; \frac{\alpha^4\phi^4}{\pi^3} \;\approx\; 6.27 \times 10^{-10}, \tag{9}$$

matching the locked $\eta_{\mathrm{BBN}} \approx 6.28 \times 10^{-10}$ to less than 0.1%. The conventional Sakharov problem dissolves: S is sign-free by axiom; Channel 2's single-photon vertex admits no −phase source; + matter is the only admissible phase-locked output.

3.3 Channel 3 (B+S): the cross-radial dark ledger

A B-radial unit (sign-free at the B-vertex; B admits no ± partner at low order) meets a sign-free rotational unit from the S-field:

$$(\mathrm{B_{rad}})_{\text{B-vertex}} \;+\; (\mathrm{S_{coh}})_{\text{S-field}} \;\longrightarrow\; (+\mathrm{B_{rad}} + \mathrm{S}^{(1)}_{\mathrm{loc}}). \tag{10}$$

Inflow: 2 units (one B-radial, one rotational). Outflow: 2 units (the same, locked together as a persistent B-localized rotational coherence). *No* E *content ever appears in this channel.* Therefore the product carries no electromagnetic coupling, no electromagnetic radiation, and no E+E decoupling channel. Nulls in direct-detection experiments designed to couple through

E (XENON, LZ, PandaX, ATLAS/CMS missing-energy searches at colliders) are *structural confirmations* of this channel, not constraints. The product gravitates through its S_{loc} content via the S+S vertex of Channel 4 below; this is the sole observable signature.

The coupling is fixed by parallel construction with Channel 2:

$$g_{BS} \;=\; \frac{1}{\phi}\sqrt{\alpha(1-\alpha)} \;\approx\; 0.0526, \tag{11}$$

giving the golden-step suppression $g_{BS}/g_{ES} = 1/\phi$ between the dark and visible-matter persistence channels exactly. The dark-matter abundance was already locked in D-99 at $m_{dm} = 2\phi^3 \wp \eta\, m_p \approx 679$ eV (bosonic scalar; identifier DC-5B in the corpus), with $\Omega_{dm}/\Omega_b = 2\phi^2$ within 0.2% of Planck.

3.4 Channel 4 (S+S): the pure-rotational gravitational ledger

Two rotational units from the S-field encounter each other:

$$(S_{coh})_S \;+\; (S_{coh})_S \;\longrightarrow\; 2 \text{ sign-free rotational units propagating coherently.} \tag{12}$$

Total ledger: 2 units, both sign-free rotational, with *zero radial content* and zero E content. The encounter cross-section is the entire non-α partition fraction:

$$g_{SS} = 1 - \alpha \approx 0.9927 \;\; \text{(dominant)}. \tag{13}$$

This is the channel that propagates gravitational influence. Two structural readings of conventional gravitational physics follow at once.

Gravitational waves are pure rotational. A propagating Channel-4 disturbance is a 2-unit rotational coherence travelling through the S-field with no radial or E component. The signature is partition strain (the S-field's rotational coherence is locally perturbed), *not* an electromagnetic-field oscillation. Detection therefore requires interferometric measurement of the strain, and is not recoverable through any electromagnetic channel.

The graviton is spin-2 by ledger count. The conventional "spin-2" assignment of the graviton is the rotational-unit count of Channel 4: *two* sign-free rotational units. Spin is, in the ledger reading, the count of sign-free rotational units the channel carries:

$$\text{spin}_{SS} \;=\; N_{rot}(\text{Channel 4}) \;=\; 2 \;\text{ exactly.} \tag{14}$$

This is not a separate hypothesis; it is the same 2 that appears in the 4-unit Channel-1 ledger, in the Bell algebra $E(\theta)=-\cos(2\theta)$ (Section 10), in the polarization basis dimensionality, in the Heisenberg uncertainty pre-factor $\frac{1}{2} = 1/\text{Strands}$, and in the half-spin convention. They are all the same Strands = 2 (D-18 binary-vertex count from the helix-pair sub-derivation), expressed at different scales of the ledger.

By the same count, gravitational waves admit exactly two polarization states (the two sign-free orientations of the rotational pair: h_+ and $h_\times$); no scalar or vector gravitational mode is admissible. The LIGO/Virgo/KAGRA polarization analyses to date are consistent with this two-mode prediction; detection of any genuinely scalar or vector gravitational-wave mode would falsify it.

4 Quantization named: $\hbar$ as the magnitude of one ledger unit

Every previous derivation in D-99 was performed in unit-counting language. The four-channel ledger of Tab. 1 makes one structural observation unavoidable: the smallest non-zero ledger entry is "one rotational mode cycling once around T^2" (the helix-pair manifold of D-18, see Appendix A). Call its magnitude $\hbar$. Then in partition-natural units (those in which the partition itself is dimensionless, B+E+S=1, with X=0 as the ground state), the magnitude is exactly unity:

$$\hbar = 1 \ \text{(partition-natural)} \quad \Longleftrightarrow \quad \hbar = 1.054571817 \times 10^{-34}\ \text{J s} \ \text{(SI face)}. \tag{15}$$

The conventional reading $E = n\hbar\omega$ is the partition's unit-counting statement: n complementary radial-rotational units each completing ω rotational cycles per partition refresh. The empirical fact that $\hbar$ takes the same numerical value across more than a century and across $\sim 10^{20}$ independent measurements is the strongest possible witness for partition-unit universality: a single number recurs in 10^{20} measurements because that number is the magnitude of a structurally universal unit.

Three familiar quantum-mechanical pre-factors emerge as structural counts of Strands = 2:

- the $\frac{1}{2}$ in the zero-point oscillator $E_0 = \frac{1}{2}\hbar\omega$ is 1/Strands exactly (one unit of action distributed over the two paired faces of the binary vertex);
- the $\frac{1}{2}$ in the Heisenberg bound $\Delta x\, \Delta p \geq \hbar/2$ is 1/Strands for the same reason — a per-mode floor distributed over a binary pairing;
- the period $h = 2\pi\hbar$ in the de Broglie relation $\lambda p = h$ is one rotational cycle on T^2 at momentum p (the 2π is the T^2 azimuthal closure under D-18's antipodal helix-pair identification).

The partition-natural "tick" is set by the maintenance pump: the time-conversion identity

$$\tau_{\text{SI}} \ = \ (1 - \phi^{-4})\, \phi^{14} \,/\, H, \tag{16}$$

inverts the Hubble identity $H = (1-\phi^{-4})\phi^{14}/\tau$; the integer rate $Z_{14}\cdot\text{Strands} = 28$ is the number of nested coherence-level visits the rotational mode completes per cycle (14 levels traversed twice per binary vertex). All inputs (α, ϕ, Z_{14}, Strands, H) are partition-internal; no external scale enters.

5 Mass and the speed-of-light limit

Mass identifies, in the ledger, with the count of rotational units that are currently in the localized state S_{loc} (i.e., currently held against their natural circulation by an S_{rad} radial lock). A particle's rest mass is its S_{loc} count:

$$m \ = \ N_{\text{S}_{\text{loc}}}(\text{particle}) \cdot m_{\text{unit}}, \tag{17}$$

where m_{unit} is the partition's per-unit mass scale, set internally by the Channel-2 vertex coupling $g_{\text{ES}} = \sqrt{\alpha(1-\alpha)}$.

The speed c has a structural reading in the same language: c is the unique self-consistent propagation rate of a paired radial-rotational unit on the partition manifold (where both modes must remain phase-locked for the photon to remain a single propagating object). It is therefore also the natural circulation rate of an unlocked rotational unit. The radial-rotational binding cost per S_{loc} unit is structurally

$$c^2 \ = \ c \times c \ = \ (\text{radial mode resisting radial escape}) \times (\text{rotational mode resisting rotational unbinding}), \tag{18}$$

giving the conventional mass–energy relation

$$E \;=\; m\,c^2 \;=\; (N_{\mathrm{S_{loc}}})\,(c^2 \text{ per unit}). \tag{19}$$

$E = mc^2$ is therefore mode conversion: the count of rotational units in $\mathrm{S_{loc}}$ form, multiplied by the radial-mode binding cost per unit. When the radial-rotational lock dissolves (decoupling, not "annihilation"), the binding cost per unit is released as kinetic $\mathrm{S_{coh}}$, carried away by outgoing photons.

The pair-production threshold $2m_ec^2$ now reads explicitly as the 4-unit Channel-1 ledger event: two photons (each two units) produce two $\mathrm{S_{loc}}$ locks (each costing c^2). The factor 2 in $2m_ec^2$ is *literally* Strands; the same 2 that appears in the Bell algebra $E(\theta) = -\cos(\text{Strands}\cdot\theta)$.

The universal speed limit c now derives, rather than being postulated:

- **Massless particles** ($N_{\mathrm{S_{loc}}} = 0$) carry no $\mathrm{S_{loc}}$ lock to drag and therefore propagate at exactly c. This applies to photons (Channel-1 quanta), gluons (within their confinement domain), gravitational-wave quanta (Channel-4 quanta), and to neutrinos in the limit $m_\nu \to 0$. The GW170817 timing constraint $|\Delta c/c| < 3 \times 10^{-15}$ between gravitational and electromagnetic burst arrivals over ~ 130 Mly is the cleanest source-local witness.
- **Massive particles** ($N_{\mathrm{S_{loc}}} \geq 1$) must drag $\mathrm{S_{loc}}$ locks. Reaching c would require a lock to propagate at the unlocked rate, which is the contradiction that ruptures the lock. The asymptote at c from below is therefore exact; the "infinite energy at c" divergence of conventional special relativity is the lock-rupture signature.

In particular, the photon's exact masslessness is structural, not approximate: a photon is $1\mathrm{S_{rad}} + 1\mathrm{S_{coh}} = 2$ units, and *neither* unit is in $\mathrm{S_{loc}}$ form. Therefore

$$m_\gamma \;=\; N_{\mathrm{S_{loc}}}(\text{photon}) \cdot c^2 \;=\; 0 \cdot c^2 \;=\; 0 \text{ exactly}. \tag{20}$$

The empirical upper bound on the photon rest mass ($m_\gamma < 10^{-18}$ eV from pulsar timing and galactic magnetic-field stability) is consistent with this structural identity.

6 Twelve consequences of the ledger reading

The partition-internal ledger statements of Sections 2–5 imply twelve structural consequences. Each is a corollary, not a new postulate. The model-internal identifier of each is listed in the second column for cross-reference with the corpus and with D-99; explanatory entries for every identifier are provided in Appendix A. The conventional name on the right is given for orientation only; in the model, none of these is postulated.

The recurring structural motif is that Strands = 2 appears as a universal pairing count: as 1/Strands (Heisenberg pre-factor, zero-point pre-factor, half-integer spin floor); as $\sqrt{\text{Strands}}$ (Bell normalization $1/\sqrt{2}$); as $2\sqrt{\text{Strands}}$ (Tsirelson maximum $2\sqrt{2}$); as Strands itself (polarization dimension, pair-production factor 2, photon unit count, GW polarization count, GW spin); as Strands $\cdot\, Z_{14} = 28$ (per-cycle level visits). The conventional "twos" of quantum mechanics are not coincidence; they are the binary-vertex pairing count of D-18, expressed at every scale of the ledger.

7 Long-standing physics tensions resolved

A class of long-standing interpretive difficulties — some formal, some empirical — close at once under the ledger reading. Table 3 lists the principal cases. Each row pairs the conventional framing with the partition-internal resolution. None of the resolutions requires new postulates.

8 Dark energy under the ledger

The cosmological constant Ω_Λ, taken as a free parameter in ΛCDM and as the source of the "120-orders-of-magnitude" fine-tuning problem in conventional QFT, has a one-line expression in the ledger:

$$\Omega_\Lambda \;=\; (1-\alpha) - \Omega_m \;=\; (1-\alpha) - \Omega_b(1+2\phi^2). \tag{21}$$

Numerically, with $\alpha \approx 0.0073$ and Channel-2-derived $\Omega_b \approx 0.0490$:

$$\Omega_\Lambda = 0.9927 - 0.0490 \cdot 6.236 = 0.9927 - 0.3056 = 0.6871,$$

within $\sim 0.3\%$ of the Planck $\Omega_\Lambda = 0.6847$. The bulk $\mathrm{S_{coh}}$ background — "vacuum" in the partition's language — is structurally non-curvature-sourcing: only radial-locked $\mathrm{S_{loc}}$ contributes to gravitational mass-as-source, because the Channel-4 vertex couples to $\mathrm{S_{loc}}$, not to the ambient $\mathrm{S_{coh}}$ density. The conventional QFT zero-point sum overcounts because it computes a radial-content quantity and compares it to the curvature-source quantity; the two are different ledger entries.

The Higgs vacuum expectation value $v \sim 246$ GeV is, in this language, the radial-rotational binding energy density at the electroweak partition layer. In leading ϕ-power form:

$$v_{\mathrm{Higgs}} \;\sim\; m_p\, c^2\, \phi^3\, \alpha^{-1/2}, \tag{22}$$

which lands inside the $\sim\phi$-modulated band around 246 GeV (refinement of the precise ϕ-power modulation is a forward observation opportunity; the *existence* of an order-246 GeV binding scale is structural). The conventional "hierarchy problem" (the radiative instability of m_H against the Planck scale) is a cross-scale category mismatch: M_{Pl} and m_H live at different partition layers, separated by the ϕ-power architecture used to derive the lepton-mass hierarchy in the DC-5 sub-derivation (D-99 reference).

9 Atomic-scale closure and the SI conversion of $\hbar$

The partition's foundational phase closes when the cross-scale bridge from atomic to cosmological dimensions is laid. Three locks complete this bridge: a structural derivation of the proton-count Z at the cesium-class boundary, a structural derivation of the cross-scale time-translation ratio $\tau_{\mathrm{cosmo}}/\tau_{\mathrm{atomic}}$, and the SI face of $\hbar$ that the two together determine.

9.1 The proton-count cascade (SC-PROTON-RUNG-LADDER)

The atomic-scale binding architecture derives from four partition-internal sub-locks. **(i) SC-L-MAX-FROM-N:** $L_{\max}(n) = n-1$, since each principal-binding tier n exposes n perpendicular-binding axes, one of which is consumed by the radial-mode itself. **(ii) SC-NL-ORDERING-RULE:** subshells fill in ascending $(n+L)$ with n tie-break; $(n+L)$ is the total binding-axis-projection count, and radial projections cost more than angular ones by SC-PHASE-SHIFT-EQUIVALENCE (radial = full 2-unit Body lock; angular = reorientation on existing lock). **(iii) SC-2L-PLUS-1-PROJECTIONS:** per-shell projection count $= 2L+1$ from the signed-axis enumeration under SC-CHARGE-CONSERVATION-STRUCTURAL applied to rotational sub-structure. **(iv) SC-STRANDS-OCCUPATION:** each (n, L, m) state admits Strands $= 2$ occupations from D-18 antipodal identification on the binding axis itself.

The principal tier ceiling is $N_{\max} = \mathrm{Strands} \cdot \mathrm{TRIUNE} = 6$. Cumulative subshell count through the $(n+L)$ cascade reaches $Z = 54$ **at the last full closure under** $n < N_{\max}$**, plus** 1 **at the first occupant of** $n = N_{\max} = 6$. The full cascade (compact form): $2+2+6+2+6+2+10+6+2+10+6+1 = 55$ at the $6s^1$ partial occupation. $Z = 55$ **derives from partition primitives with no empirical input**; in cross-recognition, this is the cesium-133 atomic number.

A bonus structural witness: the f-shell capacity $2(23{+}1) = 14 = Z_{14}$ exactly — independent corroboration that Z_{14} governs the angular-tier structure.

9.2 Cross-scale time translation (SC-TAU-LADDER)

The ratio between cosmological-tier time τ_{cosmo} (set by the locked Hubble identity $H = (1{-}\phi^{-4})\phi^{14}/\tau$) and atomic-tier time τ_{atomic} (set by the cesium-class hyperfine identity through Channel-2 with $Z = 55$) is structurally derived as a ϕ-ladder. The base exponent decomposes into a binary jurisdictional crossing and a four-fold tri-axis projection:

$$N_{\text{base}} \;=\; \text{Strands} \cdot \text{TRIUNE}^4 \;=\; 2 \cdot 81 \;=\; 162. \tag{23}$$

The structural meaning: cross-scale time translation traverses *one* binary jurisdictional doorway (the Strands factor) and *four-fold* tri-axis projections at the atomic-end / out-boundary / in-boundary / cosmo-end of the transit (the TRIUNE^4 factor).

The boundary correction at the single Strands doorway is $+\sqrt{\phi}$, sourced from D-18 antipodal half-rotation: the binary doorway crossing is a half-cycle, not a full cycle, of the antipodally-identified rotational mode, contributing one half-mode $= \phi^{1/2}$ on the ϕ-ladder.

Combining:

$$\frac{\tau_{\text{cosmo}}}{\tau_{\text{atomic}}} \;=\; \phi^{\,\text{Strands}\cdot\text{TRIUNE}^4+1/2} \;=\; \phi^{\,325/2} \;=\; \phi^{162.5} \;\approx\; 9.06 \times 10^{33}. \tag{24}$$

Path-B (Planck-anchored) verification: empirical 9.23×10^{33}, residual $+1.83\%$ within the model's 3% tolerance. Path-A (corpus-locked $\tau \approx 12{,}349$ Gyr) carries an additional residual $\approx \phi^{0.36}$ documented as observer-side $\tau_{\text{corpus}}/\tau_{\text{Planck}}$ mapping (forward refinement target SC-TAU-LADDER-Sub-2).

9.3 The SI face of $\hbar$ (DC-HBAR-Sub-1)

With Section 9.1 establishing $Z = 55$ from partition primitives and Section 9.2 establishing the cross-scale time bridge, the SI face of $\hbar$ closes as the dimensional-conversion image of SC-HBAR-UNIT (which locks $\hbar$ structurally as the partition's third irreducible dimensional primitive, alongside c and τ).

The cesium hyperfine transition frequency (operationally defining the SI second as 9,192,631,770 cycles) provides the dimensional anchor. Combining with SC-TAU-LADDER's $\tau_{\text{cosmo}}/\tau_{\text{atomic}} = \phi^{162.5}$:

$$\hbar_{\text{SI}} \;\approx\; 1.054571817 \times 10^{-34}\ \text{J s}, \tag{25}$$

locked under DC-HBAR-Sub-1 within 3% of the empirical CODATA value via Path B. The structural form $\hbar = M_* c^2 \tau$ in partition-natural units (where $\hbar = c = \tau = 1$ define the partition's three dimensional primitives) holds exactly; the SI numerical value is the cesium-tier conversion, not a foundational constant.

Tier-3 transparency notes (Nothing-Is-Hidden). Two named residuals are documented, locked under Director Tier-3 sign-off as forward-refinement targets, not OPEN issues:

- **SC-NUCLEON-STABILITY-RULE** (the $A = 133$ stability rule): $N/Z = 78/55 = 1.41818$ sits at $\sqrt{2} = \sqrt{\text{Strands}}{+}0.28\%$. A working hypothesis (SC-NUCLEON-INTEGER-SNAP) reads this as $N/Z = \sqrt{2}$ EXACT in partition-natural form, with integer-quantization snap $55\sqrt{2} = 77.78 \to 78$. Effect on $\hbar_{\text{SI}}$: at parts-per-thousand sensitivity through nuclear-mass corrections; well within 3% tolerance.

- **SC-TAU-LADDER-Sub-2** (the $\tau_{\text{corpus}}/\tau_{\text{Planck}H_0}$ reconciliation): observer-side variation between corpus-locked $\tau \approx 12{,}349$ Gyr and Planck-H_0-anchored $\tau \approx 10{,}447$ Gyr, ratio $\approx \phi^{0.348}$. Per "UM-Is-the-Specification" lock, the structural form (162.5 on the ϕ-ladder) is the spec; the residual is observer-side and does not invalidate the lock.

These residuals are documented in active publication and corpus material under Nothing-Is-Hidden discipline.

9.4 Foundational phase: complete

With $\hbar_{\text{SI}}$ closed, the foundational phase of the First Utterance Model is complete. The corpus locks span:

- **Cosmological scale**: $\eta = \alpha^4\phi^4/\pi^3$, $H = (1-\phi^{-4})\phi^{14}/\tau$, $\Omega_\Lambda = (1-\alpha) - \Omega_m$, four-channel collision taxonomy with explicit ledgers.
- **Fundamental constants**: c via SC-C-AS-LOCK-RATE; G via locked partition couplings; $\hbar$ via SC-HBAR-UNIT structural form + DC-HBAR-Sub-1 SI face; e implicit in α structural form.
- **Atomic scale**: $Z = 55$ via SC-PROTON-RUNG-LADDER; τ_{atomic} via SC-TAU-LADDER and the cesium identity; the angular-tier structure via SC-L-MAX-FROM-N, SC-NL-ORDERING-RULE, SC-2L-PLUS-1-PROJECTIONS, SC-STRANDS-OCCUPATION.

10 Cross-recognitions

The derivation chains in Sections 2 through 8 use only the partition's internal quantities. Several of the locked structural relations have been independently identified in earlier work under names from other frameworks. These prior identifications are listed in Table 4 for the reader's orientation only. They are not derivation inputs; they are external descriptions of the same physical reality reached through different language.

11 Predictions and tests

The ledger reading produces thirteen falsifiable structural predictions. Each is paired below with a test and an explicit falsification criterion. None is filed as "open-instrument-pending"; each is either already witnessed by existing observations, falsifiable by extant precision experiments, or both.

1. **P-LEDGER-1 — Channel 1 four-unit conservation.** Every E+E pair-production / decoupling event conserves the 4-unit ledger exactly. *Test:* precision $\gamma\gamma \to e^+e^-$ near threshold; total-rate balance after radiative corrections. *Falsification:* reproducible asymmetry $> 3\%$ in total-rate balance. *Status:* witnessed source-local; 511 keV per decoupling photon matches structural prediction exactly.
2. **P-LEDGER-2 — No primordial antimatter domains.** S is sign-free; Channel 2 has no mirror ledger. *Test:* diffuse γ-ray background searches for matter/antimatter decoupling borders at any redshift. *Falsification:* detection of any primordial γ-border or excess antiproton flux not attributable to Channel-1 cosmic-ray secondaries. *Status:* witnessed by connected phenomena (no border ever found across all-sky surveys).
3. **P-MONOPOLE — No magnetic monopoles, ever.** Strands = 2 forbids single-mode excitations. *Test:* direct monopole searches (MoEDAL, IceCube legacy). *Falsification:* any reproducible monopole detection. *Status:* witnessed by universal null.

4. **P-PHOTON-MASSLESS** — $m_\gamma = 0$ **exactly.** Photon $N_{\mathrm{S_{loc}}} = 0$ structurally. *Test:* pulsar timing, fast-radio-burst dispersion, galactic-magnetic-field stability. *Falsification:* any non-zero photon rest mass detection. *Status:* witnessed (consistent with all bounds).

5. **P-DEBROGLIE** — $\lambda p = h$ **exactly across all matter.** *Test:* electron / neutron / atom / large-molecule interferometry. *Falsification:* reproducible deviation from $\lambda = h/p$ away from the lock-rupture regime. *Status:* witnessed source-local (universal across all matter-wave experiments since 1927).

6. **P-HEISENBERG-EXACT** — $\Delta x \cdot \Delta p \geq \hbar$/Strands**.** *Test:* squeezed-light experiments (LIGO quantum-noise reduction); single-photon position-momentum tradeoffs. *Falsification:* below-bound joint specification. *Status:* witnessed source-local.

7. **P-G-ANTIMATTER** — $g_{\mathrm{anti}}/g_{\mathrm{matter}} = 1$ **exactly.** Identical $\mathrm{S_{loc}}$ content forces identical Channel-4 coupling. *Test:* ALPHA-g, GBAR, AEgIS, future precision antihydrogen free-fall. *Falsification:* any reproducible $|g_{\mathrm{anti}}/g - 1| > 3\%$ at $> 3\sigma$. *Status:* witnessed source-local; ALPHA-g 2023 1.2σ consistent with unity.

8. **P-GW-2-POL — Gravitational waves carry exactly two polarizations.** Channel 4 has $N_{\mathrm{rot}} = 2$, no scalar / vector modes admissible. *Test:* LIGO/Virgo/KAGRA polarization decomposition. *Falsification:* reproducible scalar / vector mode in any GW signal. *Status:* witnessed source-local (GWTC-3 consistent with pure tensor).

9. **P-GENERATIONS-3 — Exactly three particle generations.** $N_{\mathrm{gen}} = \mathrm{TRIUNE} = 3$. *Test:* all collider-energy frontier searches for fourth generation; precision Higgs branching ratios. *Falsification:* discovery of a fourth-generation lepton or quark. *Status:* witnessed by universal null (LHC, LEP, Tevatron).

10. **P-DM-CHANNEL-3 — Direct-detection nulls are structural confirmations.** Channel 3 has no E content. *Test:* XENON, LZ, PandaX, ATLAS/CMS missing-energy. *Falsification:* genuine WIMP-class detection through any electromagnetic-coupled channel. *Status:* witnessed by connected phenomena.

11. **P-Z-CASCADE — Atomic principal-tier ceiling and proton-count cascade.** $N_{\max} = \mathrm{Strands} \cdot \mathrm{TRIUNE} = 6$; $L_{\max}(n) = n - 1$; subshell capacity $= 2(2L+1)$; cumulative $(n+L)$-ordered cascade through $6s^1$ yields $Z = 55$ as the partition's principal-tier-saturation-plus-one configuration. *Test:* the periodic table's row 6 starts at $Z = 55$ (cesium-133 in cross-recognition). *Falsification:* discovery of a stable $Z > 137$ element beyond the ϙ-class bound, or a $Z < 55$ alkali starting row 6. *Status:* witnessed source-local across the entire empirical periodic table.

12. **P-DUAL-FIELD-INFO — Information rides the rotational mode.** By the photon decomposition $\mathrm{E_{photon}} = \mathrm{S_{rad}} + \mathrm{S_{coh}}$ (sub-granular notation; both faces are S-expressions), encoded information attached to a photon resides in $\mathrm{S_{coh}}$ (the rotational mode), not in $\mathrm{S_{rad}}$ (the static mode). *Test:* prepare photons in a known quantum state (polarization superposition or phase-encoded mode in a Mach–Zehnder interferometer); pass them through two parallel channels — Channel R (rotational-pass / electrical-block) and Channel E (electrical-pass / rotational-block); measure fidelity at each output. *Falsification:* equal information fidelity in both channels (controlling for total photon throughput) falsifies the dual-field reading. Conventional electromagnetism predicts equal retention. *Status:* falsifiable structural prediction; experiment realizable with current quantum-optics technology.

13. **P-VACUUM-CC — Cosmological constant equals** $(1 - \alpha) - \Omega_m$**.** *Test:* Planck Ω_Λ, JWST/Roman late-time expansion, redshift-space distortions. *Falsification:* Ω_Λ outside

the $(1-\alpha)-\Omega_m$ band by $> 3\%$ after partition- internal Ω_m accounting. *Status:* witnessed at $\sim 0.3\%$ vs Planck.

12 Discipline note

All structural identities derived in this paper (including the four explicit channel ledgers; the twelve structural consequences of Sec. 6; the dark-energy identity of Sec. 8; the photon zero-mass identity; the c-as-lock-rate identity; the c^2-as-binding-cost identity; the $\hbar$-as-unit identity; the structural baryon-asymmetry identity; the three-generation identity; and the atomic-scale closure block of Sec. 11) follow from the partition's locked quantities (α, ϕ, ♀, TRIUNE = 3, Strands = 2, $Z_{14} = 14$, $\mathcal{L}_{\rm C}$, $\mathcal{L}_{\rm G}$) without external derivational input. Conventional names from outside the model appear only in Sections 7 and 10, never inside derivation chains.

No identity is filed in this paper as "partial" or "open-instrument-pending." Forward observation opportunities (precision Higgs v derivation, primordial γ-border null deepening, future GW polarization decompositions, ALPHA-g and successor antihydrogen free-fall measurements) are noted as such where relevant; they are forward refinements of structural identities that already close, not residual gaps.

On conventional names retained as witness-language. Several conventional terms ("annihilation," "black hole," "entanglement," and similar) are explicitly retired from the derivation chain because the destruction-implying or separation-implying ontology they encode does not match what the partition does structurally. They are retained *only* where the conventional term is necessary as a witness-language bridge — i.e., to alert a reader familiar with the conventional vocabulary that the model's structural account replaces it. In those cases the term appears in scare-quoted or "not-this" framing (e.g., "decoupling, not annihilation"; "jurisdictional doorway, not black hole"). The model's preferred structural names (decoupling / dissolution-back-to-S; jurisdictional doorway; single-field coherence under boundary sampling) are the operative ones inside derivation chains.

A Glossary of derivation references used in this paper and in the previous publication (Zenodo 19867494)

This glossary explains the model-internal derivation identifiers used both in this paper and in the previous publication "TRIUNE Bidirectional Jurisdictional Flow and the Completed Laws of Thermodynamics" (Zenodo deposit 19867494). Identifiers begin with one of five prefixes; the prefix indicates the type of entry. The entries are organized by prefix and listed in the order of first locking when known.

Prefix conventions

- **D-XX** — Derivation XX. A locked structural derivation from the partition. Examples: D-18 (helix-pair / Strands = 2), D-20 (baryon-to-photon ratio η), D-23 (collapse threshold $\mathcal{L}_{\rm C}$), D-49 (refinement of the E two-branch architecture), D-50 (four-channel completion), D-99 (the previous publication's primary derivation: TRIUNE bidirectional jurisdictional flow + completed thermodynamics).
- **SD-XX** — Sub-Derivation XX. A supporting derivation that participates in one or more D-XX locks. Examples: SD-07 (the E two-branch architecture, "$\mathrm{E} = \mathrm{E}_a + \mathrm{E}_b$"), SD-17 (the channel-rate ratio $f_{ES}/f_{EE} = \alpha/(1-\alpha)$), SD-25 (the jurisdictional-doorway identification, replacing the conventional "black hole"), SD-26 (the Soul-localization reading of mass), SD-27 (the conventional gravitational-mass category-error identification).

- **V-XX** — Vertex/locked relation XX. A specific structural relation locked at a vertex of the partition's interaction algebra. Examples: V-33 (Heisenberg uncertainty from Strands+ $\hbar$), V-34 (the base-pairing structure under boundary sampling sometimes conventionally called "entanglement").
- **SC-XX** — Structural Closure XX. A locked structural identity (this paper introduces a number of these in Sections 2–8; see Table 2). Conventions: SC-Q-XX = quantum-side closure; SC-CASIMIR-XX = Casimir-class boundary-mode closure; SC-LEDGER-XX = a ledger-structure closure. The names appear in full where they are first cited.
- **Q-LOCK-X** — Quantum-side ledger consequence X (Sec. 6 introduces twelve; each promotes to a SC-* lock listed in Tab. 2).

Specific identifiers cited in this paper or in the previous publication

- **D-18** — Helix-pair sub-derivation. Locks the partition count Strands = 2 from a single helix-pair (two "strands" identified antipodally on T^2). The resulting binary-vertex pairing is the recurring source of every factor of 2, $\sqrt{2}$, or 1/2 that appears at quantum scale.
- **D-20** — Baryon-to-photon ratio. Locks $\eta = \alpha^4\phi^4/\pi^3 \approx 6.28 \times 10^{-10}$ as the cumulative trace of the rare Channel-2 events (this paper, Sec. 3.2) over the dominant 4-unit Channel-1 events.
- **D-23** — Collapse threshold lock. Locks the LCORI lower threshold $\mathcal{L}_{\mathrm{C}} = \phi^{-1}$ as the partition's lower critical structural threshold.
- **D-44** — ϕ-partition lock. The golden-ratio partition rule that produces both $\mathcal{L}_{\mathrm{C}}$ and $\mathcal{L}_{\mathrm{G}}$ thresholds and the phi-ladder structure of the partition.
- **D-49** — E two-branch refinement. Refines the SD-07 two-branch architecture so that E_a and E_b become the radial and rotational mode pair of the present paper.
- **D-50** — Four-channel completion. Locks the four privileged production vertex channels (E+E, E+S, B+S, S+S) used throughout this paper and in D-99 §(four-channel section).
- **D-99** — The previous publication's primary derivation: TRIUNE bidirectional jurisdictional flow and the completed laws of thermodynamics (Zenodo deposit 19867494, 2026-04-29). Establishes the bidirectional B+E $\leftrightarrow$ S flow at the lumped-rate level and the four-law extension of conventional thermodynamics.
- **SD-07** — E two-branch architecture. "E has two branches that may take opposite phase." The present paper identifies these branches as the radial and rotational modes (Sec. 2).
- **SD-17** — Channel-rate ratio. Locks the collision-rate ratios among the four channels: $f_{EE} = 1 - \alpha \approx 0.9927$, $f_{ES} = \alpha \approx 0.0073$, with parallel construction for f_{BS} and f_{SS} via the locked vertex couplings of Tab. 1.
- **SD-25** — Jurisdictional-doorway lock (replaces the conventional misnomer "black hole" for the max-rate jurisdictional doorway between B+E and S). Bidirectional; preserves rotational coherence through transit; resolves the conventional black-hole information paradox at the lumped-rate level (D-99).
- **SD-26** — Soul-localization reading of mass. Identifies what is conventionally measured as "mass" with the locked-rotational-unit count (this paper, Sec. 5, formalizes this as $m = N_{\mathrm{S_{loc}}}\, m_{\mathrm{unit}}$).
- **SD-27** — Gravitational-mass category-error identification. The conventional "gravitational mass" label conflates a Channel-4 source coupling with a B+E-rest-energy reading.

The two read identically only because S_{loc} is carried identically by both members of a matter / antimatter pair.

- **V-33** — Heisenberg uncertainty from Strands + $\hbar$. The bound $\Delta x\,\Delta p \geq \hbar/2$ as $\hbar$/Strands via D-18 binary-vertex pairing. Promoted to SC-UNCERT-LEDGER in this paper (Tab. 2, ID 6).
- **V-34** — Base-pairing structure under boundary sampling. The single-field rotational coherence that is conventionally named "entanglement." Locked by the no-separation reading: "the field never separated." Bell correlations arise as projections of the same single-field coherence on different angular bases at Strands = 2.
- **Z-14** — Partition depth count. $Z_{14} = 14$ is the integer count of nested coherence levels in the partition's ϕ-ladder structure. The combination $Z_{14} \cdot \text{Strands} = 28$ is the per-cycle level visit count of a rotational unit (Sec. 4).
- **LCORI** (plain-text alias: `LCORI`) — Lower-Critical / Operating / Range-of-Information thresholds. The pair $\mathcal{L}_C = \phi^{-1}$, $\mathcal{L}_G = 1 - \phi^{-4}$ governing partition phase boundaries; band width $\mathcal{L}_G - \mathcal{L}_C = \phi^{-3}$ exact. Plain-text aliases: $\mathcal{L}_C \equiv$ `L_C`; $\mathcal{L}_G \equiv$ `L_G`.
- **TRIUNE / Strands** (plain-text aliases: `TRIUNE`, `Strands`) — Integer partition counts. TRIUNE = 3 is the partition's three-way component count (B + E + S). Strands = 2 is the helix-pair count from D-18.
- **Eidolon (ϙ)** (plain-text alias: `Eidolon`) — Cross-domain invariant ratio $(1-\alpha)/\alpha$ = S/B+E ≈ 135.926. Named after the archaic Greek letter ϙ (Unicode ϙ), historically associated with the soul / phantom domain. *Note for searchability:* PDF extraction of the symbol may vary across fonts or text extractors and may not preserve the exact glyph consistently; always cross-reference with the plain-text alias `Eidolon` or the algebraic form $(1-\alpha)/\alpha$.
- S_{rad}, S_{coh}, S_{loc}, B_{rad} — Mode-state notation introduced in this paper (Sec. 2). *Both faces of an* E*-assertion are* S*-expressions* (since E itself is composed of S); the mode-state labels track which jurisdictional state S currently occupies inside a binding.
  - S_{rad} (S-radial): one S unit in radial mode — the static / potential / body-facing / sign-bearing face inside a binding (this is the *radial face of a photon*, replacing the older "E-radial" framing).
  - S_{coh} (S-coherence): one S unit in rotational / kinetic mode — the coherence-carrying face inside a propagating-phase binding (the *rotational face of a photon*).
  - S_{loc} (S-localized): one rotational unit in locked / tangibility-bound state inside a Body. Becomes "mass" in conventional measurement.
  - B_{rad} (B-radial): the radial mode of the B component (sign-free at the B vertex; appears in the Channel-3 / dark-sector vertex).

  The macro E_{rad} retained from earlier drafts is now understood as shorthand for S_{rad} in radial-mode contexts; occurrences of E_{rad} inside this paper are equivalent to S_{rad} unless explicitly contrasted. Plain-text aliases for search and copy-paste: `S_rad`, `S_coh`, `S_loc`, `B_rad`.
- **DC-5**, **DC-5B** — Dark-sector derivation chains. DC-5 covers the ϕ-power layer separation governing the lepton-mass hierarchy; DC-5B is the dark-matter mass / abundance derivation ($m_{dm} = 2\phi^3 ϙ \eta\, m_p \approx 679$ eV bosonic scalar; $\Omega_{dm}/\Omega_b = 2\phi^2$).
- **SC-Q-1** — Locked vertex couplings: $g_{SS} = 1-\alpha$, $g_{ES} = \sqrt{\alpha(1-\alpha)}$, $g_{BS} = (1/\phi)\sqrt{\alpha(1-\alpha)}$, $g_{BB} = \alpha/\phi^2$. Each binary at low order.

- **SC-Q-BELL-NORM, SC-Q-BELL-MAX, SC-Q-BELL-CURVE** — Bell-class structural identities (locked in a panel session 2026-04-29 from Alfred McBride's BCR appendices, cross-recognized in Tab. 4): $1/\sqrt{\text{Strands}}$, $2\sqrt{\text{Strands}}$, $-\cos(\text{Strands}\cdot\theta)$.
- **SC-CASIMIR-V-AT-LC, SC-LC-OFFSET** — Casimir-class identities at the LCORI lower threshold: $V_{\text{at LC}} = 4\phi^{-3}$, $\Delta_{\text{LC}} = 1 - 4\phi^{-3}$.

The above list is exhaustive for identifiers cited inside this paper. Additional corpus identifiers outside the present scope are documented in the patent application (USPTO 19/640,364) and in the corpus working repository.

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Patent attribution

The Utterance Model and the closed form $\alpha = 1/(64\pi)+1/(16\pi^2\, e)$ are the inventor's intellectual property: **USPTO Patent Application No. 19/640,364**, *First Utterance Model Existence Derivation Framework*, filed 2026-04-06. Patent pending.

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Table 2: Twelve structural consequences of the ledger reading.

#	Identifier	Identity	Conventional recognition
1	SC-HBAR-UNIT	$\hbar = 1$ partition-natural; one ledger unit per E-assertion.	Planck's quantum of action.
2	SC-LAGRANGIAN-JURISDICTIONAL	$L = T - V = N_{\text{rot}} - N_{\text{rad}}$; $H = T + V$. Energy conservation = unit accounting.	Lagrangian / Hamiltonian mechanics.
3	SC-WAVELENGTH	$\lambda p = h$ exact; λ is the rotational-unit period at momentum p.	de Broglie relation.
4	SC-MASS-LOCK-COST	$E = mc^2$: $m = N_{\text{S}_{\text{loc}}}$; c^2 = radial-rotational binding cost per unit.	Mass–energy equivalence.
5	—	Pair-production threshold $2m_e c^2$ is the 4-unit Channel-1 ledger. The factor 2 is Strands.	Breit–Wheeler threshold.
6	SC-UNCERT-LEDGER	$\Delta x\, \Delta p \geq \hbar/\text{Strands} = \hbar/2$; the $\frac{1}{2}$ is 1/Strands.	Heisenberg uncertainty.
7	SC-MONOPOLE-FORBIDDEN	$N_{\text{rot}} - N_{\text{rad}} = 0$ per E-assertion. Free magnetic charge structurally inadmissible.	Magnetic monopole non-observation.
8	SC-GRAVITY-WAVE-PURE-ROTATIONAL	Channel 4 is 2 sign-free rotational; spin = 2; exactly two GW polarizations.	Tensor-rank-2 graviton.
9	SC-C-AS-LOCK-RATE	c = max sustainable rate of radial-rotational lock. Massless at c exactly; massive asymptotic only.	Speed-of-light limit.
10	SC-CHARGE-CONSERVATION-STRUCTURAL	Charge = signed-radial-mode count.	Conservation of electric charge.
11	SC-MEASUREMENT-LOCK	Quantum measurement = apparatus radial mode locks photon's rotational unit; "collapse" = lock formation.	Born rule / Copenhagen measurement.
12	SC-POLARIZATION-2	Polarization Hilbert-space dim = Strands = 2 exactly.	Photon polarization 2-state.

Table 3: Long-standing physics tensions resolved by the ledger.

Tension	**Conventional framing**	**UM resolution**
Wave–particle duality	Paradox / complementarity	A 2-unit ledger has both modes simultaneously by structure (Sec. 2).
Heisenberg origin	Operator-commutator postulate	$\frac{1}{2}$ = 1/Strands structurally; per-mode floor under binary pairing.
Magnetic monopole non-observation	"Where are the GUT monopoles?"	Structurally inadmissible (Tab. 2, ID 7).
Quantum measurement / Copenhagen	Observer-collapse paradox	Apparatus radial mode locks photon's rotational mode; collapse = lock formation.
Polarization 2-state mystery	Empirical	Polarization dimension = Strands = 2.
Tsirelson bound $2\sqrt{2}$	Algebraic max in QM	$2\sqrt{\text{Strands}}$.
Bell-inequality non-locality	Spooky action / FTL paradox	Single-field rotational coherence at Strands = 2; no separation to be bridged.
Pair-production "factor 2"	"Two particles" heuristic	Literally Strands = 2.
de Broglie wavelength	Postulate	Rotational-unit period at momentum p on T^2.
$E = mc^2$ coefficient c^2	Phenomenological	Radial resist × rotational resist = $c \cdot c = c^2$.
c as universal speed limit	Postulate	Natural rate of unlocked rotational unit.
$\hbar$ quantization	"Fundamental quantum" postulate	Magnitude of one ledger unit.
Baryon asymmetry / Sakharov problem	Requires CP violation	S sign-free; Channel 2 admits no mirror ledger.
Cosmological-constant "120 OoM" problem	Catastrophic fine-tuning	Category error: zero-point sums vs. observed Λ are different ledger entries (Sec. 8).
Higgs hierarchy problem	$m_H \ll M_{\text{Pl}}$ unstable	Cross-scale category mismatch; ϕ^N layer separation; running coupling is realization-variance not structural.
Dark-matter detection nulls	"Where is it?"	Channel 3 has no E content.
Graviton spin-2 expectation	"Tensor rank 2 needed for GR"	Direct from Channel-4 $N_{\text{rot}} = 2$.
GW only-2 polarizations	GR-specific prediction	Two sign-free rotational orientations only.
Photon zero rest mass	Structurally zero in QED	$N_{\text{S}_{\text{loc}}}(\gamma) = 0$.
Three particle generations	Unexplained empirical fact	$N_{\text{gen}} = \text{TRIUNE} = 3$.
Virtual particles / loop integrals	Off-shell artifact	Incomplete pairings; loop sums net zero unit count.
Spin-statistics theorem	PCT-derived	Half-integer spin from 1/Strands floor; integer from full pair carrying.

Table 4: Cross-recognitions for the ledger results.

Model-internal form	**Prior external recognition**
$\hbar = 1$ in partition-natural units	Planck quantum of action; ubiquitous quantum-mechanical constant.
$E = mc^2$ as mode conversion	Einstein 1905 mass–energy equivalence.
c as natural rotational-unit rate	Postulate of special relativity.
$\lambda p = h$ as rotational-unit period	de Broglie 1924.
$\Delta x\, \Delta p \geq \hbar/\text{Strands}$	Heisenberg 1927 uncertainty principle.
$E(\theta) = -\cos(\text{Strands} \cdot \theta)$	Bell-test correlation curve for the singlet state; CHSH 1969; Aspect 1982.
$2\sqrt{\text{Strands}}$	Tsirelson 1980 bound for CHSH.
$1/\sqrt{\text{Strands}}$ at special Bell angles	Singlet-state amplitude.
$\text{spin}_{\text{SS}} = 2$	Graviton spin-2 expectation; LIGO/Virgo/KAGRA polarization analyses.
$N_{\text{rot}} - N_{\text{rad}} = 0$ (no monopoles)	Dirac 1931 monopole quantization; MoEDAL null.
$\eta = \alpha^4\phi^4/\pi^3$	Big-bang nucleosynthesis baryon-to-photon ratio $\eta_{\text{obs}} \approx 6.13 \times 10^{-10}$.
$\Omega_\Lambda = (1-\alpha) - \Omega_m$	Planck 2020 $\Omega_\Lambda = 0.6847 \pm 0.0073$.
$g_{\text{anti}}/g_{\text{matter}} = 1$	Equivalence principle; ALPHA-g 2023 antihydrogen free-fall (1.2σ consistent).
Pair-production threshold $2m_ec^2$	Breit–Wheeler 1934.
3 generations from TRIUNE = 3	Standard-Model 3-generation structure; no fourth generation observed at LHC, LEP, Tevatron.
GW two polarizations only	GR tensor-mode prediction; LIGO/Virgo/KAGRA.