Baryogenesis as a quantum-error-correction residue

The matter–antimatter asymmetry as the undetectable-fault rate of a finite QEC substrate

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Abstract

Why is the observable universe made of matter and not antimatter, when the two are produced in equal amounts and annihilate to radiation? Sixty years after Sakharov framed the problem, no mechanism derives the measured baryon-to-photon ratio $\eta \equiv n_B/n_\gamma \approx 6 \times 10^{-10}$ from first principles: grand-unified and standard electroweak baryogenesis are excluded or fine-tuned, and leptogenesis is viable only with free high-scale parameters. We present the current canon reading of the *magnitude* of η inside a finite quantum error-correcting (QEC) substrate: the self-dual $[8, 4, 4]$ extended Hamming byte, with monitored record-service firing rate $\alpha_0 = 1/137$ and boot-time erasure records supplying the photon ledger. In this picture the asymmetry is not a fine-tuned initial excess but an *error rate*: almost all matter and antimatter are erased back into photons, and the surviving baryon number is the residue of portal-licensed logical faults that bypass the code's stabilizers undetected. The minimum-weight undetectable fault has weight equal to the code distance $d = 4$, giving four monitored service firings and hence a suppression α_0^4; a colour-singlet selection over the 14 weight-4 logical channels contributes a branching 3/14; hence

$$\eta = \tfrac{3}{14}\,\alpha_0^4 = 6.08 \times 10^{-10}$$

against the Planck value $6.12(4) \times 10^{-10}$ — a 0.9σ match with no free parameters inside the R14 record-service substrate. The three Sakharov conditions map onto intrinsic features of the substrate, but with a crucial status split. The magnitude is a rule-selected closure under the record-content and service-address clauses; the lepton-number-to-baryon conversion reproduces the standard sphaleron factor 28/79 on the substrate's particle content. The absolute *sign* is sharper than before but not fully closed: the latest R1 audit identifies a CP-odd closed-boundary cochain whose sign is tied to the same global handedness used by the quark Jarlskog sign, so any nonzero $\Delta L = 2$ lepton CP invariant would pass its sign to the baryon asymmetry through the positive sphaleron factor. The remaining gates are the existence of that $\Delta L = 2$ portal and the phase magnitude; in particular the tempting C_3 character $2\pi/3$ is a CP zero in the baryogenesis invariant. All numerical claims are reproduced by self-asserting scripts.

Contents

1 The problem

Antimatter entered physics in 1931, when Dirac noticed that his relativistic electron equation demanded a positively charged partner [1]. Pair creation and annihilation are symmetric: a photon of sufficient energy makes a particle and its antiparticle together, and they annihilate back to photons. A universe that began in a state respecting the combined symmetry CPT — which all local, Lorentz-invariant quantum field theories do — should therefore contain equal amounts of each, and end as nearly pure radiation. It does not. We, the stars, and the interstellar gas are made of matter; antimatter is seen only in cosmic rays and accelerators, in minuscule transient amounts.

The asymmetry is quantified by the *baryon-to-photon ratio*

$$\eta \equiv \frac{n_B - n_{\bar{B}}}{n_\gamma}, \tag{1}$$

the net number of baryons per photon in the present universe. Two independent probes agree: primordial nucleosynthesis (the light-element abundances depend sharply on η) and the acoustic peaks of the cosmic microwave background. The Planck 2018 analysis gives [2]

$$\eta = 6.12(4) \times 10^{-10}, \tag{2}$$

i.e. roughly one surplus baryon for every 1.6 billion photons. The smallness and the nonzero-ness are equally puzzling: a symmetric universe gives $\eta = 0$, but a generic asymmetric one would not land at $\sim 10^{-9}$.

Sakharov [3] showed that *any* dynamical generation of a baryon asymmetry from a symmetric start requires three conditions to hold simultaneously:

(S1) **Baryon-number violation** — otherwise n_B is conserved and stays zero;

(S2) **C and CP violation** — otherwise any baryon-producing process is exactly matched by its mirror antibaryon-producing process;

(S3) **Departure from thermal equilibrium** — otherwise CPT forces equal occupation of a state and its conjugate.

These are necessary; they do not by themselves predict η. The history of the subject is the history of trying to realise (S1)–(S3) in a concrete model that reproduces Eq. (2) without tuning.

2 Why the standard explanations are unsatisfactory

We summarise the main routes and the reasons each is, today, either excluded or parameter-laden. Comprehensive reviews are Riotto and Trodden [4] and Canetti et al. [5].

Grand-unified (GUT) baryogenesis. The first concrete proposals [6, 7] used out-of-equilibrium, CP-violating decays of superheavy ($\sim 10^{15}$ GeV) gauge or Higgs bosons in a grand-unified theory [8] to realise (S1)–(S3). Three difficulties have accumulated. First, the electroweak *sphaleron* process [9, 10] violates $B + L$ but conserves $B - L$, and is in thermal equilibrium between $\sim 10^{12}$ GeV and the electroweak scale; it therefore *washes out* any purely $B + L$ asymmetry produced at the GUT scale, so minimal $SU(5)$ (which conserves $B - L$) generates no surviving baryon number. Second, the required reheating temperature is in tension with the upper bound from inflation and with the non-observation of GUT monopoles. Third, the simplest unified theories predict proton decay at rates already excluded by Super-Kamiokande. GUT baryogenesis is not strictly dead, but it survives only in non-minimal, $B - L$-violating, and largely untested forms.

Electroweak baryogenesis (EWBG). The Standard Model contains all three Sakharov ingredients in principle: sphalerons supply (S1), the CKM phase supplies (S2), and a first-order electroweak phase transition would supply (S3). Both fail quantitatively. The CP violation available from the CKM matrix is controlled by the Jarlskog invariant $J \approx 3 \times 10^{-5}$ divided by a high power of the electroweak scale; the resulting asymmetry is of order 10^{-20} [11, 12], ten orders of magnitude too small. And for the measured Higgs mass $m_H \approx 125\,\text{GeV}$, lattice studies show the electroweak transition is a smooth *crossover*, not first order [13], so (S3) is absent. Standard-Model electroweak baryogenesis is therefore excluded; viable variants require new scalars and new CP phases beyond the Standard Model.

Leptogenesis. The leading contender [14, 15] adds heavy right-handed Majorana neutrinos N_i (the seesaw partners). Their CP-violating, out-of-equilibrium decays create a lepton asymmetry, which sphalerons partially convert to a baryon asymmetry. Leptogenesis is attractive and not excluded, but it is not a *prediction*: the heavy neutrino masses and the CP phases in their Yukawa couplings are free parameters, and the asymmetry relevant to leptogenesis lives in the high-scale sector and is *not* fixed by the measured low-energy (PMNS) CP phase. One fits η; one does not derive it.

Affleck–Dine. In supersymmetric theories, scalar condensates along flat directions can carry large baryon number and release it as they relax [16]. The mechanism is efficient but highly model-dependent (which flat direction, which lifting operators, which initial field value), and presupposes low-energy supersymmetry that has not been observed.

The common thread: sixty years on, the *number* 6×10^{-10} is fitted, not derived. Either the dynamics are excluded (SM-EWBG, minimal GUT) or they contain enough free parameters to accommodate any value (leptogenesis, Affleck–Dine). The contribution of this paper is a route in which the magnitude is fixed, parameter-free, by the structure of the underlying code.

3 The finite-QEC substrate

We work in the "it-from-bit" framework developed in the companion canon [17]; this section states only what is needed and gives precise definitions. The reader may treat the substrate as a postulate and judge the baryogenesis result on its own terms.

Register and code. Each fundamental fermion is one codeword of a length-8 binary register, $\mathbf{c} \in \mathbb{F}_2^8$, with bit positions (§2.1 of the canon)

$$(G_0, G_1, \mathrm{LQ}, C_0, C_1, I_3, \chi, W), \tag{3}$$

encoding generation (G_0, G_1), lepton/quark LQ, colour (C_0, C_1), weak isospin I_3, chirality χ, and the weak partner bit W. The *physical* subspace $\mathcal{P} \subset \mathbb{F}_2^8$ is cut out by three constraints,

$$\text{(R1)} \quad \neg(G_0 \wedge G_1), \tag{4}$$

$$\text{(R2)} \quad W = \chi, \tag{5}$$

$$\text{(R3)} \quad (\mathrm{LQ} = 0) \Leftrightarrow (C_0, C_1) = (0, 0), \tag{6}$$

which select $|\mathcal{P}| = 48$ valid registers (one Standard-Model fermion content per generation), leaving $\mathbb{F}_2^8 \setminus \mathcal{P}$ as a 208-dimensional "invalid" (virtual, Higgs-like) subspace $\mathcal{Q}$. R1 forbids the generation corner $(G_0, G_1) = (1, 1)$, fixing the number of generations at three; R3 ties colour to the lepton/quark distinction.

The error-correcting code. The underlying linear code is the self-dual $[8, 4, 4]$ extended Hamming code $= \mathrm{RM}(1, 3)$, with weight enumerator

$$W(x) = 1 + 14\, x^4 + x^8. \tag{7}$$

It has minimum distance $d = 4$ and $k = 4$ logical qubits; the 14 codewords of weight 4 are exactly the indicator vectors of the affine hyperplanes of $\mathbb{F}_2^3$, the nontrivial logical operators of the code [18]. These two facts — $d = 4$ and the number 14 — are the only code data we use.

Dynamics, records, and the boot. A discrete-time quantum walk $\mathcal{W} = \mathcal{S}\,\mathcal{C}$ (shift $\times$ coin) propagates registers; its continuum limit is the Dirac equation. At the cosmological "boot", a Lindbladian dissipator $\mathcal{D}_\alpha$ (the QEC recovery map) projects a maximally chaotic pre-geometric state into $\mathcal{P}$, correcting errors at maximal bandwidth. Crucially, error correction is *irreversible*: each corrected fault commits a classical syndrome record. The current canon derives the bare service rate

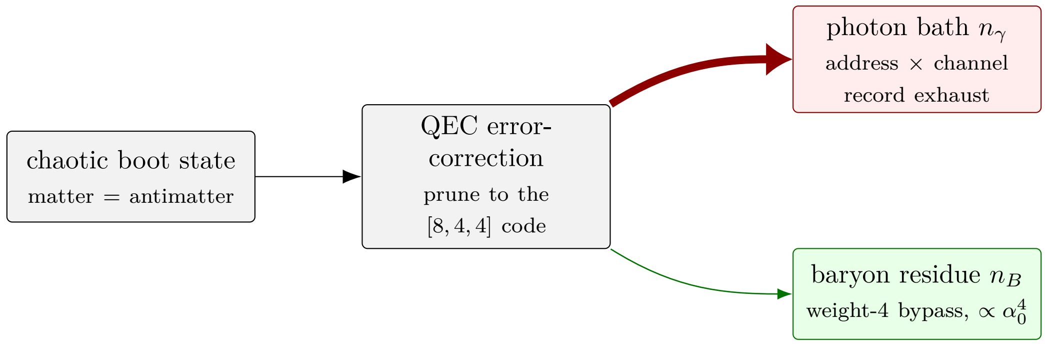
$$\alpha_0 = \frac{1}{137}$$

as the Born weight of one firing label in a symmetric record-pair service alphabet $\mathrm{Sym}^2(16) + 1$. The photon normalisation used below is not a free heat convention: the erasure event records a decoder address and a service channel, giving the record alphabet 8×137 and entropy per committed event $\ln(8 \times 137)$. This is the record-content premise used in the final η comparison.

Antimatter as the complement. Charge conjugation is the global bitwise complement

$$\bar{\mathbf{c}} = \mathbf{1} \oplus \mathbf{c} \qquad \text{(flip all 8 bits)}, \tag{8}$$

which leaves the Q_3 frustration count invariant, so a particle and its antiparticle have equal mass (substrate CPT). A central structural fact, used below, is that $\mathcal{P}$ is *not* invariant under Eq. (8): some valid codewords map to $\mathcal{Q}$. The cleanest witness is the neutrino, the all-zeros codeword $\mathbf{c}(\nu) = 00000000$; its complement 11111111 violates R1 and lies in $\mathcal{Q}$, so the neutrino has no distinct antiparticle — it is its own conjugate (Majorana). The rulebook treats the two sides of the conjugation differently. This is the substrate's intrinsic C violation.



$$\eta \;=\; n_B/n_\gamma \;=\; \tfrac{3}{14}\,\alpha_0^4 \;=\; 6.08 \times 10^{-10}$$

measured (Planck): $6.12(4) \times 10^{-10}$ (-0.9σ)

Figure 1: The cosmic error-correction ledger. The boot prunes a chaotic state onto the $[8,4,4]$ codespace; the corrected bulk is recorded as the photon exhaust ledger n_γ (thick arrow), while the rare weight-4 faults that bypass the stabilizers survive as net baryon number n_B (thin arrow). The baryon-to-photon ratio is the bypass branching $\frac{3}{14}\alpha_0^4$ with the record-alphabet photon reading — an error rate, not a fine-tuning. The three Sakharov conditions realised by this ledger are listed in Table 1.

4 Baryogenesis as the boot residue

4.1 The reframing

The conventional picture is "equal matter and antimatter, then a tiny net excess of matter." The substrate suggests a different one. The boot starts from a high-entropy chaotic state; the QEC engine prunes it onto the codespace and Landauer-dumps the pruned bulk as heat (Figure 1). *That exhaust is the photon bath:* n_γ counts erasure events, not survivors. Almost all of the symmetric matter/antimatter content is corrected away into photons. What survives as permanent baryon number is only the small residue of faults that slipped past the code's stabilizers *without being detected and corrected.*

The smallness of η is therefore not fine-tuning. It is an error rate: the probability that a charge-altering event evades the error correction, divided by the record-normalised photon exhaust ledger.

4.2 The α_0^4 scaling

To change a register's persistent (topological / baryon) charge without triggering a correction, a process must apply a *logical* operator that commutes with all stabilizers — i.e. it must flip at least d physical bits coherently, where d is the code distance. For the $[8,4,4]$ code, $d = 4$. Each non-unitary syndrome-record firing bills one factor of the monitored service rate $\alpha_0 = 1/137$; the sector-billing audit identifies the baryogenesis event as four portal-licensed, colourless weight-4 commits. Thus a coherent weight-4 undetectable fault has probability

$$P_{\text{bypass}} = \alpha_0^4 \approx 2.83 \times 10^{-9}. \tag{9}$$

That the relevant power is exactly 4 is fixed by the code distance $d = k = 4$ and by the sector-billing map: the four powers are four syndrome-record firings, not an adjustable fine-structure convention.

The dressed electromagnetic value $\alpha^{-1} = 137.036\ldots$ is a later photon-sector renormalisation. At this precision the bare record-service rate is the correct one to use; replacing it by the dressed value shifts the result well inside the observational error.

4.3 The 3/14 branching

Not every weight-4 bypass produces a net baryon. The 14 weight-4 logical channels are the affine hyperplanes of $\mathbb{F}_2^3$ (Eq. 7); a baryon-producing fault must be *colour-admissible*, i.e. avoid exciting the two-bit colour register (C_0, C_1). A two-bit veto on 14 hyperplane channels admits exactly 3:

$$\text{channels passing the 2-bit colour veto} = 3 \quad \Rightarrow \quad \text{branching} = \frac{3}{14}. \tag{10}$$

The uniform 1/14 measure on the channels is itself derived (the monitored hyperplane ledger is AGL(3, 2)-transitive, forcing equal weights); the only physical input is that the veto sector is the colour register, and the veto ladder is sector-independent (7/14, 3/14, 1/14 for one-, two-, three-bit vetoes). Combining,

$$\boxed{\eta = \frac{3}{14}\,\alpha_0^4} \qquad = \quad \frac{3}{14}\left(\frac{1}{137}\right)^4 = 6.08 \times 10^{-10}, \tag{11}$$

versus the measured $6.12(4) \times 10^{-10}$ (Eq. 2): a -0.9σ agreement in the compact baryon-to-photon reading. With the canon's current record-alphabet normalisation, the more explicit entropy-per-event comparison is

$$\eta = \frac{3}{14}\,\alpha_0^4\,\frac{(s/n_\gamma)_0}{\ln(8 \times 137)} = 6.12 \times 10^{-10} \tag{12}$$

to the present cosmology-side convention accuracy. The important point is not the last decimal; it is that the residual photon-normalisation constant has been replaced by a record-content theorem rather than fitted.

4.4 Honest accounting of the 14

A careful reader must be told a subtlety. The number 14 is the weight-4 count of the *ideal* 16-word linear [8, 4, 4] code (Eq. 7). The framework's *actual* matter set is the 48-word, non-linear R1–R3 structure of §3, which has 11 weight-4 *states*, not 14, and on which the naive 3/11 does not match $\eta/\alpha_0^4 = 0.216$. The resolution — and the sense in which Eq. (11) is to be read — is that 14 is the count of weight-4 *logical channels* (the AGL(3, 2) affine hyperplanes), not of matter states: the asymmetry is a *branching over fault channels*, and channels are not codewords. Verified by exact bijection, the 14 weight-4 ideal-code words are precisely the 14 hyperplane indicators [18]. The state-count 11 and the channel-count 14 are different objects; the baryon branching rides the channel ledger. We flag this because the earlier, state-ledger reading does not work, and the distinction is essential.

4.5 The Sakharov conditions, realised

The three conditions of §1 map onto three intrinsic features of the substrate (Table 1).

Sakharov condition	Substrate realisation
(S1) B-violation	the portal-licensed weight-4 logical event bypasses stabilizer detection and permanently alters the baryon/topological ledger ($\propto \alpha_0^4$).
(S2) C, CP violation	the codespace $\mathcal{P}$ is not invariant under the antimatter complement $\mathbf{1} \oplus \mathbf{c}$ (Eq. 8); the Majorana-neutrino witness shows the rules treat the two sides differently. The CP-odd *orientation* is not yet derived; it is the R15 recovery-holonomy frontier.
(S3) out of equilibrium	the boot-time QEC erasure is non-unitary and irreversible — the record-writing exhaust that supplies the photon ledger.

Table 1: The three Sakharov conditions and their realisation in the finite-QEC substrate.

5 Conversion of lepton number to baryon number

If, as in leptogenesis, the primary asymmetry is generated in the lepton sector, it must be converted to a baryon asymmetry by the electroweak sphalerons [10, 19], which violate $B + L$ but conserve $B - L$. This is standard thermal field theory; the only question is whether the substrate's particle content gives the standard answer. It does. With the substrate content — three generations (R1), the charge/hypercharge assignments derived from the register, and the anomaly-forced right-handed neutrino that makes $B - L$ well defined — the high-temperature chemical-equilibrium conditions (electroweak and QCD sphaleron equilibrium, Yukawa equilibrium, hypercharge neutrality) leave a one-dimensional solution space, the conserved $B - L$ direction, on which

$$B = \frac{8N_g + 4N_H}{22N_g + 13N_H}\,(B - L) = \frac{28}{79}\,(B - L) \qquad (N_g = 3,\ N_H = 1), \tag{13}$$

the Harvey–Turner factor. We stress the tiering: the conservation of $B - L$ and the particle content are substrate-native (the anomaly structure), but the equilibrium count itself is *inherited* standard physics — a consistency result, not a new derivation. (The numerical coincidence $8N_g + 4N_H = 28 = \binom{8}{2}$ with the register's pair count is contingent on $(N_g, N_H) = (3, 1)$ and is not claimed as structural.)

6 The sign: what is and is not derived

We are deliberately careful here, because "why matter and not antimatter" has a derivable magnitude and an open CP-orientation problem, and conflating them overstates the result.

There is a definite, non-cancelling net. This is structural. Because $\mathcal{P}$ is not invariant under the complement (§3), the conjugation pairs do not close on the physical spectrum, so the surviving residue cannot cancel to zero. The same non-symmetry that makes the neutrino Majorana guarantees a genuine asymmetry rather than a 50/50 state.

The magnitude is closed inside the record-service substrate. Equation (11) is no longer "free once α_0 is fixed" in the old sense: R14 derives the bare 1/137 service rate from the symmetric record-pair alphabet, and the sector audit shows that the baryogenesis event bills that service observable four times. The remaining assumptions are the framework's reconstruction floor and the record-content reading of the photon exhaust, not a continuous fit parameter.

The absolute orientation: localized, not fully closed. The documented walk is real and $\Delta L = 0$, so it cannot generate the required CP-odd sign — an exact obstruction: real, rephasable, generation-diagonal dynamics give zero weak-basis CP invariant. The admissible CP-odd carrier is a complex inter-generation Majorana recovery holonomy

$$M_H = M_0 \left[I + re^{i\sigma\Phi} A_{K_3} \right], \qquad I_{\text{CP}} = \text{Im}\left[(M_H)_{12}(M_H)_{23}(M_H)_{31} \right] = (M_0 r)^3 \sin(3\sigma\Phi), \tag{14}$$

which is $\Delta L = 2$ and flips sign under orientation reversal when $\sin(3\sigma\Phi) \neq 0$. The new R1 result identifies the sign carrier more sharply. The CP-even R1 object is the two-edge Hasse-path covariance used in the δ sector; the CP-odd object is instead the closed oriented R1 boundary cochain, including the endpoint–endpoint edge. This cochain transforms in the S_3 sign representation, and multiplication by the global substrate orientation line makes it a scalar Stinespring pointer. Thus the *sign* of a lepton CP invariant, if the $\Delta L = 2$ portal exists and has nonzero phase, is tied to the same handedness that fixes the quark Jarlskog sign. The sphaleron conversion is positive, so it preserves that sign:

$$\text{sign}(\eta_B) = \text{sign}(I_{\text{CP}}).$$

Two caveats are essential. First, the portal and phase magnitude remain live gates; they are not derived in this paper. Second, the faithful C_3 value $\Phi = 2\pi/3$ is not a baryogenesis phase, because $\sin(3\sigma\Phi) = \sin(2\pi\sigma) = 0$. Candidate nonzero phases such as $\Phi = 1/3$ or $2\pi/9$ would carry an orientation sign, but selecting one is the phase theorem. So the sign result is a conditional correlation theorem, not a complete sign derivation.

In short: the substrate predicts *how much* asymmetry survives and supplies a structural C asymmetry. The CP sign has a credible R1/global-orientation carrier, but it remains conditional on the $\Delta L = 2$ portal and nonzero phase theorem.

7 Status, reproducibility, and falsifiability

Reproducibility. Every numerical statement is checked by self-asserting scripts in the reproducibility repository [20]; each exits 0 only if all its assertions pass. The relevant scripts are:

- `item126_channel_ledger.py`: the 3/14 branching, uniform measure, and η.
- `item126_weight4_event_algebra.py`: the local weight-4 event algebra.
- `scheduler_alpha_composition.py`: selection of the α_0^4 composition rule.
- `alpha0_record_pair_symmetry_theorem.py`: the bare service-rate count.
- `alpha0_downstream_billing_map_audit.py`: the baryogenesis sector billing map.
- `record_alphabet_derivation.py` and `record_content_from_syndrome.py`: the photon record-content reading.
- `item126_48set_count.py`: the honest state-ledger contrast of §4.4.
- `item126_sphaleron_conversion.py`: the 28/79 factor.
- `item87_deltaL2_holonomy_coupling.py`: the CP-sign iff target.
- `item126_baryon_sign_from_orientation.py`: earlier global-orientation sign audit ($I_{\text{CP}} \propto \sin(3\sigma\Phi)$; $2\pi/3$ is a CP zero), now qualified by the R1 boundary-cochain bridge below.

- `item87_r1_orientation_leptogenesis_bridge.py`: separates the CP-even R1 Hasse-path covariance from the CP-odd closed R1 boundary cochain and records the conditional sign handoff to baryogenesis.

- `item126_sign_lock_convention_audit.py`: honest audit — the $J \leftrightarrow \eta$ lock is convention-free, but the same/opposite-sign *value* rides on the generation-map parity (J flips under odd relabelling, generation-blind $I_{\rm CP}$ does not).

- `item126_jh_parity_and_handedness.py`: resolves that parity — lepton-portal generation-blindness + even-parity quark map (forced by near-identity CKM) fix the correlation to *same-sign*; the residue is one CPT-frame handedness label.

Falsifiability. The magnitude is the sharp prediction. Because $\eta = \frac{3}{14}\alpha_0^4$ has no free continuous parameter inside the R14 substrate, any future tightening of the measured η, of the entropy-per-photon convention, or of the dressed-versus-bare α comparison that moved the two apart by more than the combined error would falsify the result at leading order. The prediction is specific to the code data (d, 14, 3) and to the record-content reading; a different code distance, channel count, or photon ledger would give a different power, rational prefactor, or entropy factor.

8 Discussion

The matter–antimatter asymmetry has been, for six decades, a number in search of a mechanism. The mechanisms on offer either die on contact with data (Standard-Model electroweak baryogenesis; minimal grand unification) or carry enough free parameters to fit any value (leptogenesis, Affleck–Dine). The proposal here is structurally different: it does not add arbitrary new high-scale fields or phases for the magnitude, but reinterprets the early universe as a finite record-writing quantum error-correcting substrate and reads the asymmetry off the code's service ledger. The conceptual payload is one sentence — *the baryon asymmetry is an error rate, not a fine-tuning* — and it comes with the compact number $\eta = \frac{3}{14}\alpha_0^4 = 6.08 \times 10^{-10}$, with the fuller record-normalised reading landing at the current Planck value to cosmology-side convention accuracy.

We have been explicit about the boundary between what is derived and what is not. The magnitude is a conditional closure under the record-service substrate; the lepton-to-baryon conversion is standard physics on the substrate's content; the existence of a definite net is structural; and the CP sign now has a sharply identified R1/global-orientation carrier. The novel and testable content is still primarily the magnitude and its origin in code distance, channel counting, and record billing. The open frontier is no longer a vague appeal to a geometric sign: it is the concrete task of deriving a $\Delta L = 2$ complex recovery holonomy and a nonzero phase from the boot/QEC layer.

Acknowledgements. This work is part of the it-from-bit canon [17]. The symmetric-mass-generation structure underlying the charged-sector gap draws on Wang and You [21].

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Claim	Tier	Basis
$\eta = \frac{3}{14}\alpha_0^4 = 6.08 \times 10^{-10}$ (-0.9σ compact reading)	Computed	channel-ledger branching plus R14 record-service rate
α_0^4 scaling from code distance $d = 4$	Computed	four syndrome-record firings in a minimum-weight undetectable logical event
3/14 colour-veto branching	Computed	$\mathrm{AGL}(3, 2)$ hyperplane ledger; uniform measure derived
record-alphabet photon normalisation	Conditional	address $\times$ service-channel record content; selected before the η comparison
$(B - L) \to B = 28/79$ conversion	Inherited	standard sphaleron equilibrium on substrate content
existence of a definite non-zero net	Computed	$\mathcal{P}$ not complement-invariant
absolute sign / CP orientation	Conditional	R1 supplies a closed-boundary sign cochain which, after multiplication by the global orientation line, can carry the lepton CP sign. The positive sphaleron factor would pass this sign to baryons. Remaining gates: derive the $\Delta L = 2$ portal and a nonzero phase magnitude; $2\pi/3$ is a CP zero.

Table 2: Status of the claims in this paper. Computed: parameter-free inside the stated record substrate and numerically verified. Inherited: standard physics on substrate inputs. Conditional: closed under an explicitly named premise. Open frontier: current canon does not derive it.