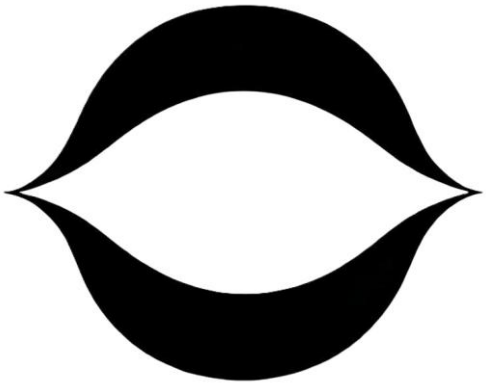

The Surplus

Artist's Proof 26

Baryon Asymmetry

Why more matter than antimatter — the ash of the break

Status and Dependency

This paper derives the structural form of the baryon asymmetry of the universe from the core axiom. It does not derive the numerical value. It derives the form.

The universe contains approximately one excess baryon for every billion photons. This ratio, $\eta \approx 6 \times 10^{-10}$, is one of the most precisely measured numbers in cosmology.

The standard account requires baryogenesis — a process during the early universe that generated a slight excess of matter over antimatter, satisfying the Sakharov conditions.

The axioms offer a different account: the asymmetry is not generated by a process. It is structural. It is the axiom itself.

The core axiom is 1:1 + 1×ε. The 1:1 is the symmetric component. The ε is the break.

This paper shows that when the axiom is read as an energy partition, the baryon asymmetry ratio follows directly: $\eta = E(\varepsilon) / (1 + E(\varepsilon))$, where $E(\varepsilon)$ is the dimensionless energy of the break.

The form is derived. The value of $E(\varepsilon)$ is a formal debt.

The dependency chain: Axiom S (distinction) → Axiom B (single break) → core axiom (1:1 + 1×ε) → AP06 (leakage constant, $\varepsilon > 0$) → AP18/AP21 (Energy–Measure Bridge, $\mu \to E$) → AP22 (the ledger: σ-asymmetry, topological protection of the surplus) → AP24 (the residual: all constants as projections of ε) → AP25 (the measure: Born rule, normalisation) → this paper (energy normalisation → partition → baryon asymmetry form).

Epistemic status per section. §1 (The Problem): historical. §2 (The Axiom as Energy Partition): derived — Lemma 1 grounds the partition in AP25's measure theory and the Energy–Measure Bridge. §3 (The Form): derived — Proposition 1. §4 (Why the Surplus Survives): derived — Proposition 2, topological protection via AP22. §5

(Connection to the Leakage Constant): derived. §6 (The Formal Debt): debt. §7 (The Deeper Point): synthesis — non-load-bearing.

Notation

η — the baryon-to-photon ratio. Observed value: $\eta \approx 6.1 \times 10^{-10}$ (Planck 2018).

E(ε) — the dimensionless energy of the break. Defined as $E(\varepsilon) = \mu(\varepsilon) / \mu(1{:}1)$, where μ is the additive measure on the record monoid (AP18 Lemma 1, AP21 Energy–Measure Bridge).

$E(\varepsilon)$ is a pure number in (0, 1), determined by the self-consistency conditions (AP24).

1:1 — the symmetric component of the axiom. In the energy partition, the component whose matter and antimatter contributions cancel perfectly upon annihilation.

1×ε — the break. The asymmetric component. The surplus that has no mirror image and therefore cannot annihilate.

ε_leak — the leakage constant (AP06). The non-zero probability that energy leaks past a perfect absorber. Identified with the break: $\varepsilon = \varepsilon\_leak$.

σ — the orientation-reversal operator on the manifold (AP22). The break ε has no σ-image: $\sigma(\varepsilon)$ is undefined.

g* — the effective number of relativistic degrees of freedom at a given energy scale. Relevant to the precise mapping between the energy ratio $E(\varepsilon)$ and the observed number ratio η.

Kill Switches

KS-58 (Surplus form): LIVE — EMPIRICAL. Structurally secure.

KS-59 (Topological protection): LIVE — EMPIRICAL. Proton decay not observed.

KS-60 (Derived value mismatch): LIVE — DEBT. The most exposed quantitative prediction in the corpus.

Here is how to destroy this paper. Derive $E(\varepsilon)$ from the self-consistency conditions and show it does not equal 6×10^{-10}.

That kills the axiom's energy partition and the entire constant-unification programme of AP24 in one stroke.

Or observe proton decay at a rate sufficient to erase the asymmetry within the age of the universe — that kills the topological protection.

Or show that the baryon asymmetry depends on a parameter independent of the fundamental constants — that kills the structural form. The argument hands you these weapons.

The last one — KS-60 — is the sharpest blade in the corpus.

§1 — The Problem of the Baryon Asymmetry

You are made of the leftovers.

The universe is made of matter. Not antimatter. This is strange. The laws of physics are nearly symmetric between matter and antimatter.

For every process that creates a particle, there is a corresponding process that creates its antiparticle.

If the universe began in a symmetric state — equal parts matter and antimatter — then all the matter should have annihilated with all the antimatter, leaving nothing but photons.

A universe of light and no structure.

Instead, approximately 10^{80} baryons and essentially zero primordial antibaryons. The baryon-to-photon ratio $\eta \approx 6.1 \times 10^{-10}$ tells us that for every billion matter-antimatter pairs that annihilated, roughly one extra baryon survived.

A surplus of one part in a billion.

The standard account (Sakharov, 1967) identifies three necessary conditions for generating this asymmetry: (1) baryon number violation, (2) C and CP violation, and (3) departure from thermal equilibrium.

These conditions are necessary but not sufficient — the Standard Model satisfies all three but cannot produce a large enough asymmetry. The precise mechanism of baryogenesis remains one of the open problems in physics.

The axioms offer a different account. The asymmetry is not generated by a dynamical process during the early universe. It is structural. It is present in the axiom itself, before any dynamics occur.

§2 — The Axiom as Energy Partition

The core axiom is 1:1 + 1×ε. This is not a metaphor. It is the irreducible structure from which all else follows. The 1:1 is the symmetric component — the self-balancing ratio.

The 1×ε is the break — the asymmetric remainder that exists because the break is real (ε > 0, AP06).

Read this axiom as an energy partition. But first: why can the symmetric component be normalised to 1?

Lemma 1 (Energy Normalisation). The total energy budget of the symmetric component normalises to 1. This normalisation is inherited from the probability measure derived in AP25.

Proof. AP25 (The Measure) derives the Born rule as the unique probability measure on outcomes of actualisation: μ(P) = Tr(|ψ⟩⟨ψ| · P).

This measure normalises to 1 by construction — the probabilities for all outcomes of a complete measurement sum to 1 (AP25, Lemma 1: orthogonal additivity; Axioms S + B: normalisation).

The symmetric component (1:1) is the set of all paired records: every particle matched by its antiparticle, every outcome matched by its conjugate.

The total measure of this set is the total probability of all pairwise-cancelling outcomes, which exhausts the symmetric sector.

By AP25's normalisation, this total is 1. The break ε sits outside the symmetric sector (it has no σ-image, AP22).

Its measure is μ(ε) = E(ε), defined via the Energy–Measure Bridge (AP18/AP21) as the ratio μ(ε)/μ(1:1) = E(ε)/1 = E(ε). Therefore: the total energy budget is 1 + E(ε). ■

The total energy of the universe is thus distributed between two components:

Component 1: The symmetric energy. The energy associated with the 1:1. This energy condenses into matter-antimatter pairs in equal measure. When these pairs meet, they annihilate completely, converting their energy into radiation (photons).

This is the cosmic microwave background — the echo of the symmetric component's annihilation. Normalise this component to 1.

Component 2: The surplus energy. The energy associated with the break ε. This energy does not have a symmetric counterpart. It is the uncancellable remainder.

It cannot annihilate because there is nothing for it to annihilate with. This is the matter that forms stars, galaxies, and observers.

The total energy is therefore $1 + E(\varepsilon)$, where $E(\varepsilon)$ is the dimensionless energy of the break. The surplus fraction is $E(\varepsilon) / (1 + E(\varepsilon))$.

You have watched a bonfire burn. The fire consumes everything that has a partner — fuel meets oxygen, matter meets antimatter, and both become light and heat.

When the fire is done, only the ash remains. The ash is what had no partner. The ash is ε.

The universe is made of ash — one part in a billion — and the cosmic microwave background is the light of the fire that consumed everything else.

§3 — The Form

Proposition 1 (The Surplus Ratio). Let $E(\varepsilon)$ be the dimensionless energy of the break. The baryon asymmetry ratio takes the structural form $\eta = E(\varepsilon) / (1 + E(\varepsilon))$.

Proof. The core axiom partitions reality into two components: the symmetric (1:1) and the break ($1{\times}\varepsilon$). The symmetric component produces equal quantities of matter and antimatter. Upon annihilation, this component converts entirely to radiation (photons).

The break component produces a surplus that has no antimatter counterpart (AP22: the break has no σ-image) and therefore survives annihilation as baryonic matter.

The total energy budget is $E_{total} = E_{symmetric} + E_{surplus} = 1 + E(\varepsilon)$ (normalising the symmetric component to 1).

After annihilation, the energy in radiation is $E_{radiation} = 1$ (from the symmetric annihilation) and the energy in surviving baryons is $E_{baryons} = E(\varepsilon)$ (from the surplus). The baryon-to-photon energy ratio is:

$\eta_E = E_{baryons} / E_{radiation} = E(\varepsilon) / 1 = E(\varepsilon)$.

The surplus as a fraction of total energy (surplus-to-total ratio) is:

$\eta = E(\varepsilon) / (1 + E(\varepsilon))$.

For $E(\varepsilon) \ll 1$ (which is established: the break is small), these two expressions are equivalent to leading order: $E(\varepsilon) / (1 + E(\varepsilon)) \approx E(\varepsilon)$. ■

§3.1 — The energy-to-number mapping

Proposition 1 derives an energy ratio. The observed baryon-to-photon ratio $\eta \approx 6.1 \times 10^{-10}$ is a number ratio (baryons per photon), not directly an energy ratio.

The relationship between the two depends on the thermodynamics of the annihilation epoch.

At the annihilation epoch (~1 GeV), the average photon energy and the baryon mass are of comparable order, so the energy ratio and number ratio approximately coincide.

However, the precise mapping may carry a coefficient g_eff related to the effective number of relativistic degrees of freedom g* at the annihilation temperature. The general form is:

$\eta = E(\varepsilon) / (g\_eff \cdot (1 + E(\varepsilon)))$

where g_eff absorbs the thermodynamic factors that convert the energy partition into a particle number ratio. In the simplest case, g_eff = 1 and Proposition 1's form is exact.

In the general case, g_eff is a calculable number that depends on the particle content at the segregation epoch.

This is not a weakness of the derivation — it is a precision question. The structural form (surplus fraction of total energy) is derived and locked.

The coefficient g_eff determines whether the mapping is direct or carries a thermodynamic correction. Determining g_eff requires knowing the segregation epoch and the particle spectrum at that epoch. This is Debt D2.

§4 — Why the Surplus Survives

Proposition 1 assumes that the surplus energy survives annihilation. This is not automatic. Why doesn't the surplus find something to annihilate with?

Proposition 2 (Topological Protection). The surplus E(ε) is topologically protected against annihilation. The break ε has no σ-image (AP22). Therefore the surplus has no antimatter counterpart and cannot annihilate.

Proof. AP22 (The Ledger) establishes that the orientation-reversal operator σ maps the matter sector ($\mathcal{L}$-sector) to the antimatter sector ($\mathcal{P}$-sector).

AP22's Proposition 1 proves that σ(ε) is undefined: the break has no σ-image because it is the entity that generates the $\mathcal{L}/\mathcal{P}$ distinction itself. It cannot be mapped across a boundary that it creates.

For every $\mathcal{L}$-record of the symmetric component, σ produces a corresponding $\mathcal{P}$-record: these are the matter-antimatter pairs that annihilate. But the break ε has no corresponding $\mathcal{P}$-record.

Therefore: the energy E(ε) associated with the break has no $\mathcal{P}$-sector counterpart. There is no antimatter for it to annihilate with. The surplus is topologically protected. ■

Note: This is the axioms' replacement for the Sakharov conditions. The standard account requires a dynamical process to generate the asymmetry during the early universe.

The axioms' account is that the asymmetry is structural — it exists in the axiom before any dynamics. The Sakharov conditions describe how an asymmetry could be generated from a symmetric initial state.

The axioms say the initial state was never symmetric: it was 1:1 + 1×ε. The asymmetry is primitive.

You have balanced a ledger. Every entry has a matching entry on the other side — except one. One line item with no counterpart.

You cannot cancel it because there is nothing to cancel it against. That line item is the visible universe.

Everything you have ever touched, tasted, or thought about is the one uncancellable entry in a ledger that otherwise balances perfectly.

§5 — Connection to the Leakage Constant

AP06 (The Leakage Constant) proves that the break has a physical manifestation: the leakage probability ε_leak > 0. This is the non-zero probability that in any interaction, some energy leaks past what would otherwise be a perfect absorber.

The leakage is a consequence of the finiteness of c (Axiom C) and the irreversibility of records (Axiom R).

The identification ε = ε_leak connects the abstract break to a physical quantity. E(ε) is the leakage probability expressed as an energy ratio: the fraction of total energy that leaks through the symmetric annihilation process.

Corollary (Leakage Interpretation). The baryon asymmetry ratio η is the energy-weighted leakage fraction of the universe's total energy budget. η = ε_leak / (1 + ε_leak).

The physical picture: the annihilation of the symmetric component is not perfectly efficient. A fraction ε_leak of the total energy leaks through. This leaked energy is the baryonic matter of the observable universe.

The cosmic microwave background is the radiation from the symmetric annihilation. The baryon asymmetry is the ratio of leak to total.

Connection to AP24. AP24 (The Residual) establishes that all fundamental constants are projections of ε. The fine-structure constant α_em, the electron mass m_e, the gravitational constant G, and ε_leak are all faces of one object.

This means E(ε) is not a free parameter — it is determined by the self-consistency conditions that fix the values of all the constants simultaneously.

The value of the baryon asymmetry is locked to the values of α_em, m_e, and G by the self-consistency. If you know any one constant, in principle you know them all.

Schematically, AP24's self-consistency has the structure of a fixed-point condition: $\varepsilon = f(\varepsilon)$, where f encodes how the break's energy determines the coupling constants, which in turn determine the energy scales at which the break manifests.

The function f is implicit in the derivation chain: $\varepsilon \rightarrow$ Hilbert space structure (AP07) $\rightarrow$ gauge group (AP15, AP16, AP19) $\rightarrow$ coupling constants $\rightarrow$ running of couplings (RGE) $\rightarrow$ low-energy value of ε.

The unique fixed point of this chain is the physical value of $E(\varepsilon)$. Making this chain explicit and solving for ε^* is the content of Debt D1.

§6 — The Formal Debt

**This paper derives the form of the baryon asymmetry ratio. It does not derive the value. The form is $\eta = E(\varepsilon) / (1 + E(\varepsilon))$. The value requires deriving $E(\varepsilon)$ from first principles.

This is a formal debt.**

§6.1 — What must be computed

The debt is: derive the dimensionless value $E(\varepsilon)$ from the self-consistency conditions established in AP24. The target is $E(\varepsilon) \approx 6 \times 10^{-10}$, which would yield $\eta \approx 6 \times 10^{-10}$ (since $E(\varepsilon) \ll 1$).

§6.2 — Two paths to the value

Path 1 (Direct computation). Derive the full Standard Model particle spectrum as harmonics of ε. Write the renormalisation group equations with the derived spectrum.

Run the couplings from the Planck scale (where E(ε) = 1, the break is total) to low energies.

The unique low-energy value of E(ε) that produces self-consistent values for α_em ≈ 1/137 and m_e ≈ 0.511 MeV is the answer. This path requires deriving the particle spectrum first (a major undertaking).

Path 2 (Fixed-point method). AP24 identifies a fixed-point structure: ε = f(ε), where f encodes the self-consistency conditions. Formulate f explicitly and solve for the non-trivial fixed point.

If f has a unique stable fixed point in (0, 1), that fixed point is E(ε). This path is more elegant but requires formulating f, which itself depends on the coupling structure.

§6.3 — The energy-to-number coefficient

The mapping from the energy ratio $E(\varepsilon)$ to the observed number ratio η may carry a thermodynamic coefficient g_{eff} related to the effective degrees of freedom at the annihilation epoch.

Determining whether $g_{eff} = 1$ (the direct mapping) or $g_{eff} \neq 1$ (requiring a correction) is part of the debt.

§6.4 — What this debt does NOT include

This debt is about the numerical value of E(ε).

The following are NOT debts — they are derived results: the form of the baryon asymmetry ratio (Proposition 1), the topological protection of the surplus (Proposition 2, from AP22), the identification of E(ε) with the leakage constant (Corollary, from AP06), and the connection to fundamental constants via AP24's self-consistency.

The structural account is complete. The universe has a baryon asymmetry because the axiom is 1:1 + 1×ε, not 1:1. The form is forced. The value is the remaining calculation.

§7 — The Deeper Point

Synthesis note: the following is non-load-bearing language. It carries no epistemic weight beyond the claims established above.

The standard account of the baryon asymmetry requires a sequence of specific physical events during the early universe: baryon number violation, CP violation at the right level, departure from equilibrium at the right moment.

It is a story about process. Something happened to tip the balance.

The axioms' account is different. Nothing tipped the balance. The balance was never there. The axiom is not 1:1. It is $1{:}1 + 1{\times}\varepsilon$. The asymmetry is not generated. It is primitive.

It exists before space, before time, before any process. The surplus is the break itself, read as energy.

The reason you exist — the reason there is matter rather than just light — is that the axiom has a remainder. The universe is not perfectly symmetric. It never was.

The imperfection is one part in a billion, and it is everything: every star, every planet, every thought. The splinter that escaped.

§8 — Kill Switches

Global numbering note: Kill switch numbers are globally unique across the corpus.

KS-58 — Surplus form (EMPIRICAL). Proposition 1 derives the form $\eta = E(\varepsilon) / (1 + E(\varepsilon))$.

If the baryon asymmetry is found to have a structural form incompatible with this energy partition — for example, if η depends on a parameter independent of the fundamental constants (and therefore independent of ε) — Proposition 1 fails.

Status: LIVE — EMPIRICAL. Structurally secure.

KS-59 — Topological protection (EMPIRICAL). Proposition 2 derives that the surplus is topologically protected via AP22's σ-asymmetry.

If baryon number violation is observed at a rate sufficient to erase the asymmetry — if the surplus can annihilate through baryon-number-violating processes faster than the age of the universe — then the topological protection fails.

Status: LIVE — EMPIRICAL. Proton decay has not been observed. Current experimental bounds (Super-Kamiokande: $\tau_p > 10^{34}$ years) are consistent with topological protection. Structurally secure.

KS-60 — Derived value mismatch (DEBT). When $E(\varepsilon)$ is eventually derived from the self-consistency conditions (Debt D1), it must yield $\eta \approx 6.1 \times 10^{-10}$ (Planck 2018 value) via the form $\eta = E(\varepsilon) / (g_{eff} \cdot (1 + E(\varepsilon)))$.

If the derived value does not match the observed η, the axiom's energy partition is wrong or the self-consistency conditions of AP24 contain an error.

Status: LIVE — DEBT. This is not merely a test of this paper. It is a test of AP24's central claim — that all physical constants are unified as projections of a single object, ε.

If the self-consistency conditions that fix α_em, m_e, and G also fix E(ε), and if that value matches the observed η, then the entire constant-unification programme is confirmed by a cosmological observable.

If it does not match, either the self-consistency conditions contain an error or the axiom's energy partition is wrong. This is the sharpest blade in the corpus. The argument hands it to you.

§9 — Conclusion

The baryon asymmetry of the universe has a structural form that follows directly from the core axiom.

The axiom is 1:1 + 1×ε. Read as an energy partition: the symmetric component (1:1) annihilates into radiation; the break (ε) survives as the baryonic surplus.

The ratio of surplus to total is $\eta = E(\varepsilon) / (1 + E(\varepsilon))$. The surplus is topologically protected: the break has no σ-image (AP22) and therefore no antimatter counterpart.

The energy of the break is the leakage constant (AP06), which is itself a projection of ε through the self-consistency conditions of AP24.

**The form is derived. The value is a debt. When the self-consistency conditions of AP24 yield a unique value for $E(\varepsilon)$, that value must match the observed $\eta \approx 6.1 \times 10^{-10}$.

This is the most exposed quantitative prediction in the corpus.**

Claim Summary

Derived: Energy normalisation via AP25 measure theory and AP18/AP21 Energy–Measure Bridge (Lemma 1). Structural form of the baryon asymmetry ratio (Proposition 1, from core axiom as energy partition).

Topological protection of the surplus (Proposition 2, from AP22 σ-asymmetry). Identification of E(ε) with the leakage constant (Corollary, from AP06). Connection to fundamental constants via AP24 self-consistency.

Debt: D1 — numerical value of E(ε). Requires deriving E(ε) from AP24 self-consistency conditions. Target: $E(\varepsilon) \approx 6 \times 10^{-10}$. Two paths: direct computation via particle spectrum, or fixed-point method via f(ε) = ε.

D2 — energy-to-number coefficient g_eff to be determined.

Conditional on: Nothing. EH and QRA proved in AP20. Axioms unconditional.

Depends on: Core axiom (1:1 + 1×ε), AP06 (leakage constant), AP18/AP21 (Energy–Measure Bridge), AP22 (the ledger, σ-asymmetry, topological protection), AP24 (the residual, self-consistency conditions), AP25 (the measure, Born rule, normalisation).

Formal results: Lemma 1 (Energy Normalisation, DERIVED). Proposition 1 (Surplus Ratio, DERIVED). Proposition 2 (Topological Protection, DERIVED). Corollary (Leakage Interpretation, DERIVED).

Kill switches: KS-58 (surplus form, EMPIRICAL, LIVE). KS-59 (topological protection, EMPIRICAL, LIVE). KS-60 (derived value mismatch, DEBT, LIVE).

Don’t be a cunt. Be kind.

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