



The Ratio

Artist's Proof 03

Relativity

c derived as the conjugacy of propagation and resistance

Abstract

The two fundamental constants of physics — the propagation limit c and the gravitational coupling G — are not independent. They are conjugate expressions of a single symmetry-breaking event.

The pre-geometric symmetric state S possesses \mathbb{Z}_2 (binary) symmetry. Its spontaneous breaking with amplitude ε produces exactly two fundamental sectors: a propagation sector (Mode 1) and a resistance sector (Mode 0).

From a minimal pre-geometric action, the emergence of c follows as the ratio of substrate stiffnesses in the broken phase.

The emergence of G from the same action remains an open problem — the conjecture that G is determined by ε is structurally motivated but not yet derived.

If the conjecture holds, the dimensionless gravitational coupling α_G is not independent of ε , and the Planck mass scales as $m_p \propto \varepsilon$.

The black hole event horizon is the surface where the break becomes locally marginal. A structural identity between the cosmological origin and the horizon follows.

The dark-to-visible energy density ratio is a qualitative consequence of small ε . Explicit falsification conditions are provided.

A work of natural philosophy: structural architecture, not completed quantitative theory. You will find the derivation of c . You will find the conjecture on G . You will find the kill switches that can destroy both.

Contents – Voice V

Naming note: “Edition” numbers refer to prose voice publications of the 420 Code. The formal voice equivalents are Artist’s Proofs (APs). Edition 03 = AP03 (The Ratio). Edition 04 = AP06 (The Leakage Constant).

Where this paper cites an Edition, the formal derivation is in the corresponding AP.

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Appendices: Appendix A – The Action Principle: Derivation of c from ε ; Conjecture on G Appendix B – The \mathbb{Z}_2 Representation Theorem Appendix C – The Horizon Analysis Appendix D – Experimental Signatures and Observational Tests Appendix E – Axiom Mapping: $\{S, B, R, C\} \leftrightarrow \text{AP03 Postulates}$

Conditionality Footer

§0. Status and Dependency

AP03 is logically independent of every other Artist's Proof. AP01 takes the universe as given and develops an operational architecture for quantum irreversibility within it.

AP03 asks a prior question: how do the fundamental constants that define the arena arise?

Failure of AP03 does not affect AP01. Failure of AP01 does not affect AP03. But if AP03 holds, it provides the deeper ground from which the AP01 Paper B gravitational rate bound inherits.

The rate limit on actualization becomes a downstream consequence of ε , not an independent postulate. A structural bonus, not a dependency.

AP03 depends on nothing. Its two postulates (E0, E1) are self-contained. Its derivations require only standard representation theory and scalar field theory.

It is structurally related to AP05 (Lorentzian spacetime), AP08 (Einstein field equations), AP17 (0-pole/1-pole structure), and AP24 (all constants as projections of ε).

What AP03 does. Two fundamental constants — c and G — are proposed as conjugate expressions of a single symmetry-breaking event with amplitude ε .

The propagation speed c is derived from a minimal pre-geometric action (Appendix A). The gravitational coupling G is conjectured to be determined by ε (Conjecture E-G, KS-74).

If the conjecture holds, the Planck mass scales as $m_p \propto \varepsilon$, and the event horizon is the marginal surface where the break becomes locally zero.

Epistemic status. §0-3: STRUCTURAL.

Postulates E0, E1 motivated by minimality; \mathbb{Z}_2 decomposition theorem (E2) proven.

§4.1-4.2: PARTIALLY DERIVED — c derived from action (Result A.1, KS-73); G

conjectured (KS-74). §4.3–4.6: CONDITIONAL on Conjecture E-G. §5: CONDITIONAL (E-Identity, KS-75, depends on E-G). §6: QUALITATIVE CONJECTURE (E5, KS-77, not quantitative).

Appendix A: DERIVED (c) + CONJECTURED (G). Appendix B: PROVEN. Appendix C: CONDITIONAL on E-G. Appendix D: OPERATIONAL.

Terminology. AP03 uses its own claim labelling (E0, E1, E2, ... E5, E-Assignment, E-Bootstrap, E-Identity, E-Hawking, E-G). These predate the corpus-wide KS numbering. The mapping is in the conditionality footer.

The axiom set {S, B, R, C} was formalised after AP03; the mapping is in Appendix E.

Outstanding debts. D1 (G derivation): derivation of G from the pre-geometric action — central open problem, blocks KS-74, KS-75, KS-76. D2 (Substrate parameters): derivation of α , β , or a symmetry argument fixing their ratio — c is parameterised but not predicted.

D3 (Dark sector functional form): quantitative mapping $\varepsilon \rightarrow$ (dark/visible ratio) — blocks KS-77. D4 (Temporal/spatial distinction): the kinetic term presupposes τ vs x distinction — deepest open problem, prior to D1.

Corpus Editor's Note (Final Collation): Debt D1 has been substantially reduced. The structural forcing argument (AP20: Axiom B forces one parameter \rightarrow G cannot be independent of ε) proves G is determined.

The scaling relation $G = \kappa/(\varepsilon\Lambda^2)$, equivalently $c/G \propto \varepsilon$, was derived via the Sakharov/backreaction route (Edition 03/Paper E) and verified numerically ($\varepsilon \approx 10^{-45}$, $c/G \approx 10^{38}$).

The MOND floor $a_0 \approx cH_0$ was derived from axioms in AP18. AP24 established all constants as projections of ε . Status: structurally resolved. The explicit axiomatic derivation (without Sakharov mechanism as external input) remains open.

The disclosed circularity in $G = 2\kappa/m^2$ (AP08 §5) is acknowledged.

Kill switches. KS1 (Independent variability): LIVE — EMPIRICAL, targets KS-74. KS2 (Non-binary origin): LIVE — EMPIRICAL, targets KS-71, KS-72. KS3 (Dark ratio

independence): LIVE — EMPIRICAL, targets KS-77. KS4 (Horizon inequivalence): LIVE — HARD, targets KS-75. KS5 (Planck scale mismatch): LIVE — EMPIRICAL, targets KS-73. KS6 (Scaling violation): LIVE — HARD, targets KS-74, becomes operational when D1 is resolved.

Here is how to destroy AP03. Six ways. The argument hands you the weapon.

§1. The Two Speed Limits

You know one of them. You have felt it your entire life without naming it. Light crosses the room before your hand finishes reaching for the switch. Nothing outruns it. Nothing negotiates with it.

That limit is c .

There is a second one. You have felt it too, but it hides inside a different experience. You have never been told its name because physics does not yet agree on what to call it.

§1.1 The Propagation Limit

Special relativity identifies c as the maximum velocity at which information, energy, or causal influence can propagate through spacetime. Not a property of light alone — a structural constraint on the geometry of spacetime itself.

The Lorentz group enforces c as the invariant velocity linking space and time coordinates.

§1.2 The Gravitational Rate Bound

General relativity identifies gravity not as a force but as spacetime curvature sourced by mass-energy, with G as the coupling constant that sets the curvature response.

In certain quantum gravity proposals — including the gravitational self-energy decoherence models of Diósi and Penrose, and the rate-limiter hypothesis of AP01 Paper B — gravitational self-energy imposes a bound on how fast quantum superpositions can resolve.

How fast possibility becomes definiteness. The bound scales with the mass and spatial extent of the superposition. It is system-dependent, unlike c which is universal.

§1.3 Same Kind, Different Domain

Both c and G are structural speed limits. Both are non-negotiable. But they govern different processes.

c : limits how fast information propagates across space — horizontal, movement through the arena.

G : limits how fast superposition resolves into definiteness — vertical, collapse of possibility into fact.

They cannot be identical. c is universal and flat. The gravitational rate bound is system-dependent and scales with mass. But both may emerge from the same underlying structure.

If spacetime geometry enforces c , and gravitational self-energy enforces the selection rate, and gravity is spacetime geometry — the central insight of general relativity — then both limits are expressions of the same geometric constraint acting on different degrees of freedom.

You have lived inside both speed limits your entire life. One governs how fast the light reaches your eye. The other governs how fast the world decides what to show you.

AP03 proposes they are siblings — conjugate outputs of the same event.

§2. Before the Arena

§2.1 The Bootstrap Problem

Consider the moment of symmetry breaking — the transition from the symmetric pre-state to the broken state that becomes our universe. At that exact moment:

No spacetime. The geometric arena has not yet formed. c , as a property of spacetime geometry, cannot yet exist as a constraint.

No mass. Mass-energy has not yet differentiated. G , as a coupling to mass-energy, cannot yet exist as a constraint.

Both c and G are properties of the broken state. They emerge from the break. They cannot govern the break that produces them.

You cannot use the rules of the house to explain how the house was built. The house did not exist yet.

You cannot invoke the speed limits of the universe to explain how the universe acquired its speed limits. That is the bootstrap problem.

§2.2 The Only Available Constraint

At the moment of symmetry breaking, the only available parameter is the magnitude of the asymmetry itself. Call it ε .

The break occurs because the symmetric state S is unstable — an infinitesimal perturbation of amplitude ε grows, separating the broken state from the symmetric state.

The rate of that separation cannot exceed ε itself, because ε is the only scale in the problem at that moment. No external clock. No background metric. No pre-existing coupling constant to set the rate.

Scope note: “ ε is the speed limit” means: in the absence of any pre-existing metric or clock, ε is the only available scale for the growth rate of the unstable mode.

A dimensional and structural claim, not a dynamical derivation.

Claim E-Bootstrap. The first speed limit in the universe is ε . Both c and G inherit from ε .

They are downstream expressions of the original constraint, specialised to different degrees of freedom in the broken phase. Status: structural argument (§2). Not yet formalised in the action. ■

You have just watched the first constraint appear. Not decreed. Not chosen. Forced — by the fact that there was nothing else available. Everything that follows inherits from that single scale.

§3. The Minimal Break — Why Exactly Two Sectors

§3.1 The Symmetry Group of the Pre-State

The symmetry of the pre-state S is proposed to be \mathbb{Z}_2 — the cyclic group of order 2. Exactly two elements: the identity and a single involution (a transformation that is its own inverse).

The question is not “what symmetry does the pre-state have?” in the empirical sense. The question is: what is the minimal symmetry that, when broken, produces a non-trivial universe?

A state with no symmetry (the trivial group) cannot break — it is already maximally asymmetric. A state with \mathbb{Z}_2 symmetry is the simplest state that can undergo non-trivial symmetry breaking.

If the universe arises from the minimal possible break, the symmetry group must be \mathbb{Z}_2 .

Postulate E0 (KS-71) (\mathbb{Z}_2 Minimality). The symmetric pre-state S has \mathbb{Z}_2 symmetry. The simplest non-trivial symmetry group. Motivated by parsimony but not derived from first principles. ■

You might object: why \mathbb{Z}_2 ? Why not something richer? Because richer is not simpler. And the question was: what is the minimum? The minimum is two.

The formal proof that \mathbb{Z}_2 admits exactly two irreducible representations is in Appendix B.

§3.2 The \mathbb{Z}_2 Decomposition

When a \mathbb{Z}_2 symmetry breaks spontaneously, the state space decomposes into exactly two sectors:

The even sector (+1 eigenvalue): states invariant under the \mathbb{Z}_2 involution.

The odd sector (−1 eigenvalue): states that flip sign under the \mathbb{Z}_2 involution.

Theorem 3.1 (\mathbb{Z}_2 Decomposition). The irreducible representations of \mathbb{Z}_2 are exactly two: the trivial representation and the sign representation. Any representation of \mathbb{Z}_2 decomposes into copies of these two.

There cannot be a third fundamental sector. Proof: Appendix B. ■

You cannot argue with this. It is not a claim about the universe. It is a theorem about \mathbb{Z}_2 . The group has two irreducible representations. Not three. Not one. Two. The mathematics does not negotiate.

Critical distinction: The theorem guarantees two sectors (fundamental categories), not two particle species. Each sector may contain many dynamical degrees of freedom — multiple particle species, bound states, domain walls, other structures.

The Ising model has \mathbb{Z}_2 symmetry; its broken phase contains magnetisation, spin-wave excitations, domain walls, and bound states. All belong to either the even or the odd sector.

The representation theorem constrains the number of fundamental categories, not the richness of physics within each category.

§3.3 Identification of Sectors

Scope note: The following identification of sectors with physical modes is a modelling assumption motivated by the structure of the broken phase, not a theorem consequence. The \mathbb{Z}_2 decomposition (Theorem 3.1) guarantees two sectors.

The assignment of physical roles requires an additional argument: the odd sector (V_-), being maximally displaced by the break, is the natural carrier of propagation — content that separates, moves, carries information.

The even sector (V_+), being invariant under the break, is the natural carrier of resistance — content that holds, resists separation.

Structurally natural but not unique; an assumption (E-Assignment) that could in principle be falsified independently of $E\emptyset$.

Mode 1 (Propagation sector): The odd sector. Content maximally displaced by the break. Whatever moves, separates, carries information away from the origin.

In the broken phase, its limiting velocity becomes c . The entire Standard Model gauge structure lives within Mode 1.

Mode 0 (Resistance sector): The even sector. Content invariant under the break. Whatever stays, holds, resists separation. In the broken phase, its coupling strength is conjectured to become G .

The sector may contain internal structure — potentially including the distinct phenomenologies of dark matter and dark energy.

Claim E2 (Binary Decomposition, KS-72). The symmetry-breaking event produces exactly two fundamental sectors because the symmetry group of the pre-state is \mathbb{Z}_2 , whose representation theory admits exactly two irreducible representations.

The internal structure within each sector is downstream and unconstrained by this theorem. Status: proven (Appendix B, depends on $E\emptyset$). ■

Two categories. Everything that moves. Everything that holds. The entire universe, sorted at birth into two bins by a theorem that has been known since the 19th century. You already sensed this. Light and gravity.

Speed and weight. The mathematics just proved you right.

§4. The Conjugacy of c and G

Every Planck unit whispers the same secret. You have never noticed because the textbooks treat it as a dimensional coincidence. Look closer. It is not a coincidence. It is a fingerprint.

§4.1 Planck Units as Evidence

Every Planck unit contains both c and G . Never one alone:

$$l_p = \sqrt{(\hbar G / c^3)}$$

$$t_p = \sqrt{(\hbar G / c^5)}$$

$$m_p = \sqrt{(\hbar c / G)}$$

Conventionally treated as dimensional bookkeeping. AP03 proposes a structural interpretation: c and G always appear together in Planck units because they are not independent. They are conjugate outputs of the same break.

The Planck scale is the regime where the two modes are barely distinguishable — the scale of the break itself.

§4.2 What Is Derived and What Is Not

In Appendix A, the minimal pre-geometric action with \mathbb{Z}_2 symmetry is constructed. In the broken phase, perturbations propagate with speed:

$$c^2 = \beta / \alpha \quad (4.1)$$

where α and β are pre-geometric substrate parameters (temporal and spatial stiffness). A genuine derivation: c emerges as a property of the broken vacuum, not as an input.

Structurally identical to the emergence of the speed of sound in condensed matter.

What is not derived: The gravitational coupling G . AP03 conjectures that G is also determined by ε , but the conjecture has not been derived from the action.

The analogue gravity programme (Unruh 1981, Barceló, Liberati & Visser 2005) provides an effective metric for perturbations on a condensate background, but it does not provide a dynamical gravitational coupling — the background metric in analogue gravity is fixed, not sourced by stress-energy.

The step from “effective metric” to “effective Newton’s constant” requires showing that perturbations source the metric they propagate on. The emergent gravity problem. Unsolved in this architecture.

Conjecture E-G (Gravitational Conjugacy, KS-74). The emergent gravitational coupling is controlled by the condensate sector and therefore depends on ρ_0 , c , and the UV scale Λ . Define the dimensionless gravitational coupling $g_G \equiv G\Lambda^2$.

The conjecture is that g_G is a function of ε (and possibly λ and β/α).

The specific scaling ansatz $c/G \propto \varepsilon^2$ is a provisional hypothesis, not a derived consequence of the present action, and requires a completed dimensional derivation before numerical use.

If the conjecture holds, the Planck mass $m_p \propto \varepsilon$. Physically motivated: stronger condensate \rightarrow stiffer vacuum \rightarrow weaker effective gravity. Not derived. The central open problem. ■

Corpus Editor's Note: KS-74 status upgraded from LIVE — HARD to STRUCTURALLY FORCED by the AP20 forcing proof.

The conjecture that G is determined by ε is no longer a conjecture — it is a theorem consequence of Axiom B (one parameter).

The explicit scaling $G = \kappa/(\varepsilon\Lambda^2)$, with $c/G \propto \varepsilon$ (correcting AP03's original $c/G \propto \varepsilon^2$), was derived in subsequent work. See AP20 §P.3, Edition 03 Paper E, AP18, AP24.

You have just watched a speed limit emerge from nothing. Not postulated. Not measured. Computed — from the stiffness of the substrate that the break left behind.

The mathematics does not care whether you find this beautiful. It computes.

§4.3 The Event Horizon as the Marginal Surface

The Schwarzschild radius of a mass M is:

$$r_s = 2GM / c^2 \quad (4.2)$$

At that radius, the escape velocity equals c . The propagation mode (Mode 1) can no longer outrun the resistance mode (Mode 0). The break becomes locally marginal. Inside the horizon, Mode 0 dominates.

Outside, Mode 1 has room to run. The detailed analysis is in Appendix C.

Structural interpretation: The event horizon is the surface where the local value of the symmetry-breaking parameter reaches zero. The boundary between the broken phase (exterior) and the restored phase (interior).

A black hole is a local restoration of the pre-break symmetry.

§4.4 Hawking Radiation as Proof of Global Asymmetry

If the interior of a black hole represents local symmetry restoration, then Hawking radiation has a structural interpretation: the global asymmetry ($\varepsilon > 0$ everywhere in the broken phase) prevents the local restoration from being complete.

The break leaks through the horizon. The global condition $\varepsilon > 0$ is non-negotiable within a universe that exists because $\varepsilon \neq 0$.

A structural reason why black holes must evaporate: a permanently stable local restoration of symmetry within a globally broken phase is a contradiction. The broken phase is the universe.

The universe does not permit pockets of perfect symmetry to persist indefinitely within itself.

Conjecture E-Hawking (KS-76). Hawking radiation is the necessary consequence of imposing a global $\varepsilon > 0$ condition on a locally $\varepsilon \rightarrow 0$ region. Status: structurally motivated, not derived from the action principle.

Depends on E-Identity. ■

You have watched a black hole try to undo the break. And you have watched the universe refuse. The radiation is the refusal. The mathematics does not judge. It leaks.

§4.5 The Planck Mass as the Scale of the Break (Conditional)

If Conjecture E-G holds (G determined by ε), then from $c/G \propto \varepsilon^2$ and the definition of the Planck mass $m_p = \sqrt{(\hbar c/G)}$:

$$m_p \propto \varepsilon \quad (4.3)$$

The Planck mass would be directly proportional to the breaking amplitude — the mass scale at which gravitational and quantum effects are comparable, which is precisely where the two sectors become marginally distinguishable.

Conditional on the unproven E-G conjecture.

§4.6 Unit-Invariant Formulation (Conditional on E-G)

The core claim must be expressed in dimensionless terms. The natural candidate is the gravitational fine-structure constant:

$$\alpha_G(m) = Gm^2 / (\hbar c) \quad (4.4)$$

The dimensionless measure of gravitational coupling strength at mass scale m . For the electron, $\alpha_G(e) \approx 1.75 \times 10^{-45}$. At the Planck mass, $\alpha_G(m_p) = 1$ by definition.

Conditional Claim E4 (Dimensionless Conjugacy). If E-G holds, the gravitational fine-structure constant α_G at any fixed mass scale is not independent of ε .

The hierarchy $\alpha/\alpha_G \sim 10^{43}$ at the electron mass would be a consequence of the breaking amplitude, not a coincidence. The mass at which $\alpha_G = 1$ (the Planck mass) would scale as ε .

The dimensionless formulation is the correct target for any quantitative test. Statements about the dimensionful ratio c/G are unit-dependent shorthand. ■

You have wondered why gravity is so absurdly weak compared to electromagnetism. Forty-three orders of magnitude weaker. If the conjugacy holds, that number is not a mystery. It is ε , measured.

§5. The Origin and the Horizon

You have looked at the night sky and wondered where it all began. You have read about black holes and wondered where it all ends.

The chain of reasoning in §2 and §4 reveals they are the same place.

(Note: the identity analysed in detail in Appendix C. Its status depends on Conjecture E-G. If E-G is false, the identity is not established.)

The Big Bang: the moment ε first becomes nonzero. The symmetric state breaks. Mode 1 separates from Mode \emptyset . The universe begins. Viewed forward in time.

The black hole event horizon: the surface where ε locally returns to zero. Mode \emptyset recaptures Mode 1. The break closes. Viewed backward in time.

The same condition — the marginal boundary between broken and unbroken symmetry — encountered from opposite temporal directions. The Big Bang is the break opening. The event horizon is the break closing.

The Planck scale is the scale of the break itself.

Claim E-Identity (KS-75). The cosmological origin and the black hole event horizon are structurally identical — both are the marginal surface $\varepsilon = \emptyset$ of the \mathbb{Z}_2 break, traversed in opposite directions.

The detailed analysis is in Appendix C. Status: depends on E-G conjecture. Structural interpretation, not derivation. ■

Corpus Editor's Note: Since KS-74 is now structurally forced, the conditional status of KS-75 is upgraded.

The structural identity between origin and horizon is no longer dependent on an unproven conjecture, but on a structurally forced result. See also AP04 (The Loop Hypothesis), AP17 (The Room), AP22 (The Ledger).

A key consequence: the Schwarzschild radius $r_s = 2GM/c^2$ encodes the ratio G/c^2 — Mode 0 over Mode 1 — scaled by mass.

For any given quantity of matter, it identifies where the break becomes marginal again.

The beginning and the end are the same door. You walk through it in different directions. You have been walking through it your entire life without knowing.

§6. The Dark Sector Connection

§6.1 The Observed Ratio

The observed energy density of the universe decomposes approximately as: dark energy ~68%, dark matter ~27%, visible matter ~5%. The total dark sector constitutes ~95% of the energy budget.

The visible sector — matter that interacts electromagnetically, that propagates and radiates — constitutes ~5%.

§6.2 Structural Expectation

If ε is small, the break displaces only a small fraction of the total content into Mode 1 (the propagation mode). The majority remains in Mode 0 (the resistance mode).

You already see where this lands. You have read the numbers. Ninety-five percent of the universe's energy budget is dark — resistant to electromagnetic interaction, gravitationally dominant. Qualitatively consistent with a small ε .

A small break means most of what exists stayed behind.

The precise energy partition between Mode 0 and Mode 1 depends on the initial conditions of the symmetry-breaking event, specifically the spectrum of initial fluctuations (see Appendix A, §A.5).

The qualitative prediction is robust: for small ε , Mode 0 dominates. The quantitative mapping requires a model of the initial fluctuation spectrum, which remains an open derivation.

§6.3 Caveats

Three specific issues require resolution before the connection becomes quantitative.

First: dark matter and dark energy are phenomenologically distinct. Dark matter clusters gravitationally; dark energy does not. If both belong to Mode \emptyset , internal structure within Mode \emptyset must account for the distinction.

One possibility: dark matter represents the massive excitations of Mode \emptyset (fluctuations of the even sector with mass from the potential curvature), while dark energy represents the residual vacuum energy of the condensate itself.

Structurally natural but requiring derivation.

Second: the 95:5 ratio is epoch-dependent. At recombination, the ratio was different. In the far future, dark energy dominates completely.

If ε sets the ratio, it must set the initial condition from which the ratio evolves via standard Friedmann cosmology, not the present-day snapshot.

Third: the quantitative mapping $\varepsilon \rightarrow$ (dark/visible ratio) requires a specific functional form, not yet derived.

Conjecture E5 (Dark Sector, KS-77). The dark-to-visible energy density ratio is determined by ε . Small ε implies most content remains in Mode \emptyset . Status: qualitative. Not a prediction until the functional form is derived. ■

§7. Scope and Deferral

AP03 is a work of natural philosophy. It asks a structural question — are c and G conjugate? — and answers it with an architecture, a minimal action, and a scaling relation.

Not a completed physical theory.

The derivations required to elevate the architecture to a quantitative theory include: (1) a first-principles derivation of the pre-geometric substrate parameters α and β (or a symmetry argument fixing their ratio); (2) a derivation of G from the scalar field action without importing the analogue gravity proportionality; (3) the exact numerical coefficient in $c/G \propto \varepsilon^2$; (4) the energy partition function between Mode 0 and Mode 1 as a function of ε and cosmological epoch; (5) the internal structure of Mode 0 that accounts for the phenomenological distinction between dark matter and dark energy.

Subsequent work addresses these. AP03 is not that work. AP03 is the structural ground from which that work proceeds. If you want the completed quantitative theory, you will have to wait.

If you want the structural architecture that makes the theory possible, you are reading it.

Foundational limitation (acknowledged): The kinetic term (Appendix A, equation A.4) presupposes a distinction between temporal and spatial coordinates (τ vs x) — a structural input, not an output.

A truly pre-geometric formulation would derive the distinction rather than assume it. $c = \sqrt{\beta/\alpha}$ is parameterised by the substrate, but the substrate's anisotropy is not itself explained.

The deepest open problem in AP03, distinct from and prior to the G derivation.

§8. Falsification Conditions

AP03 is falsified if any of the following are demonstrated. Each kill switch targets a specific claim. If any claim falls, the dependent claims fall with it, but independent claims survive.

Here is how to break it. The argument does not hide. It shows you exactly where to strike.

Kill Switch 1 (LIVE — EMPIRICAL): Independent Variability of Dimensionless Couplings

Targets: E3, E4.

If the dimensionless gravitational coupling $\alpha_G(m) = Gm^2/(\hbar c)$ at a fixed reference mass is shown to vary independently of the electromagnetic fine-structure constant $\alpha = e^2/(4\pi\epsilon_0\hbar c)$ — if a consistent observation demonstrates that α_G and α can be tuned independently with no common ancestor parameter — then the conjugacy claim is wrong and AP03 fails at its core.

Experimental test: Quasar absorption spectra constrain cosmological variation of α . Lunar laser ranging and Big Bang nucleosynthesis constrain α_G .

AP03 predicts these variations are correlated: any shift in α attributable to a shift in c must be accompanied by a specific correlated shift in α_G . Uncorrelated variation falsifies the architecture.

See Appendix D, Test 1.

Kill Switch 2 (LIVE — EMPIRICAL): Non-Binary Origin

Targets: E0, E2.

If the early universe is shown to require more than two fundamental mode sectors at the moment of symmetry breaking — not merely more than two particle species, but

more than two irreducible sectors of the symmetry decomposition — then the \mathbb{Z}_2 postulate is wrong.

Experimental test: Detection of a third fundamental sector that is neither gravitationally coupled (Mode 0) nor electromagnetically coupled (Mode 1) — a sector that does not reduce to either — triggers this kill switch.

Kill Switch 3 (LIVE — EMPIRICAL): Dark Ratio Independence

Targets: E5.

If the dark-to-visible energy density ratio is shown to be determined by a mechanism entirely independent of the c/G relationship, then the dark sector connection fails.

Note: kills only the E5 conjecture, not the core claims E0–E4.

Kill Switch 4 (LIVE — HARD): Horizon Inequivalence

Targets: E-Identity.

If the cosmological origin and the black hole event horizon are shown to be structurally inequivalent — for example, if the singularity theorems have fundamentally different character for cosmological vs. black hole singularities in a way incompatible with the $\varepsilon = 0$ interpretation — then Claim E-Identity fails.

Kill Switch 5 (LIVE — EMPIRICAL): Planck Scale Mismatch

Targets: E-Bootstrap, equation (4.3).

If quantum gravity effects onset at a scale parametrically different from the Planck scale in a way incompatible with $m_p \propto \varepsilon$, then the identification of the Planck scale as the scale of the break fails.

Kill Switch 6 (LIVE — HARD): Scaling Violation

Targets: Conjecture E-G (Appendix A, §A.5), Conditional Claim E4 (§4.6).

If a completed derivation of E-G yields a definite scaling relation between c , G , and ε , and that relation is shown false by direct measurement or by internal inconsistency, then the conjugacy programme fails at its core.

At the current stage, $c/G \propto \varepsilon^2$ is a conjectured scaling ansatz, not a derived result. The sharpest kill switch. Requires the completion of the build programme (§7) to become fully operational.

Six kill switches. All live. None are hedges. They are invitations. You want to destroy AP03? Pick one. The argument will not stop you.

It will hand you the blade and show you where to cut.

§9. Summary of Claims

AP03 makes the following claims, in order of decreasing confidence. Each is tagged with its epistemic status and its dependency.

E0 (Postulate, KS-71): There exists a symmetric pre-state S with \mathbb{Z}_2 symmetry.

Status: foundation. Not derived. Motivated by minimality.

E1 (Postulate): S is unstable. A symmetry-breaking event occurs with amplitude ε .

Status: foundation. Not derived. Consistent with standard SSB physics.

E2 (Derived from E0, KS-72): The break produces exactly two fundamental sectors because \mathbb{Z}_2 admits exactly two irreducible representations. Each sector may contain rich internal structure. Status: proven (Appendix B). Depends only on E0.

E3 (Partially derived, KS-73): The limiting velocity of the propagation sector becomes $c = \sqrt{(\beta/\alpha)}$, derived from the pre-geometric action.

The conjecture that the coupling strength of the resistance sector becomes G , also determined by ε , is not yet derived. Status: c derived (Appendix A). G conjectured (Appendix A, §A.5).

The G derivation is the central open problem.

E4 (Conjecture, conditional on KS-74): c and G are not independent constants.

They are conjugate, both determined by ε . In dimensionless terms: α_G at any fixed mass scale is determined by ε .

Status: depends on E-G conjecture. Not established.

E-Assignment (Modelling assumption): The odd sector carries propagation (Mode 1, c); the even sector carries resistance (Mode 0, G). Status: physically motivated by the structure of the broken phase. Not derived from E0 alone.

E-Bootstrap (Claim): ε is the first and most fundamental speed limit, from which c and G inherit. Status: argued in §2. Structural, not yet formalised in the action.

E-Identity (Conditional claim, KS-75): The cosmological origin and the black hole event horizon are the same marginal surface ($\varepsilon = 0$), traversed in opposite directions. Status: depends on E-G conjecture. Structural interpretation, not derivation.

E-Hawking (Conjecture, KS-76): Hawking radiation is the necessary consequence of global $\varepsilon > 0$ imposed on a locally $\varepsilon \rightarrow 0$ region. Status: structurally motivated. Not derived. Depends on E-Identity.

E5 (Conjecture, KS-77): The dark-to-visible energy density ratio is determined by ε . Small ε implies most content remains in Mode 0. Status: qualitative. Not a prediction until functional form is derived.

§10. Notation Reference

S: The symmetric pre-state.

ε : The amplitude of the symmetry-breaking perturbation. Dimensionless ratio μ^2/Λ^2 .

\mathbb{Z}_2 : The cyclic group of order 2. The symmetry group of S.

Mode 1: The propagation mode (odd sector of \mathbb{Z}_2). That which moves. c.

Mode 0: The resistance mode (even sector of \mathbb{Z}_2). That which holds. G.

c: The speed of light. The limiting velocity of Mode 1 in the broken phase. $c^2 = \beta/\alpha$.

g_G : Dimensionless gravitational coupling. $g_G \equiv G\Lambda^2$. The dimensionless target for the E-G conjecture.

G: Newton's gravitational constant. Conjectured coupling strength of Mode 0. Conjectured, not derived.

$\alpha_G(m)$: Gravitational fine-structure constant at mass scale m. $\alpha_G(m) = Gm^2/(\hbar c)$. Dimensionless measure of gravitational coupling strength. $\alpha_G(e) \approx 1.75 \times 10^{-45}$; $\alpha_G(m_p) = 1$ by definition.

α, β : Pre-geometric substrate parameters. Temporal and spatial stiffness respectively.

λ : Self-coupling constant of the φ^4 potential.

Λ : Fundamental (UV) scale of the pre-geometric theory.

v: Vacuum expectation value. $v = \Lambda\sqrt{(\varepsilon/\lambda)}$. The order parameter of the break.

χ : Perturbation field. $\varphi = v + \chi$. The excitation above the broken vacuum.

ρ_0 : Condensate energy density. $\rho_0 = \varepsilon^2\Lambda^4/(4\lambda)$.

l_p , t_p , m_p : Planck length, time, mass. If E-G holds: the scale of the break. $m_p \propto \varepsilon$ (conditional).

r_s : Schwarzschild radius. The surface where Mode 0 recaptures Mode 1. $r_s = 2GM/c^2$.

Appendix A. The Action Principle

Derivation of c from ε ; conjecture on G

A.1 Strategy

The simplest possible action for the pre-state S is constructed satisfying three requirements: (i) \mathbb{Z}_2 symmetry, (ii) symmetry-breaking vacuum parameterised by a single amplitude ε , and (iii) broken phase yielding two quantities identifiable with c and G , both determined by ε .

The analogue gravity programme (Unruh 1981, Barceló, Liberati & Visser 2005) serves as a structural template, not as a physical identity.

A.2 The Pre-Geometric Action

Let φ be a real scalar field with \mathbb{Z}_2 symmetry ($\varphi \rightarrow -\varphi$). The most general renormalisable potential respecting this symmetry is:

$$V(\varphi) = -\frac{1}{2}\mu^2\varphi^2 + \frac{1}{4}\lambda\varphi^4 \quad (\text{A.1})$$

with $\mu^2 > 0$ (symmetric point unstable) and $\lambda > 0$ (potential bounded below). The minima occur at $\varphi = \pm v$ where:

$$v = \mu / \sqrt{\lambda} \quad (\text{A.2})$$

The dimensionless breaking amplitude:

$$\varepsilon \equiv \mu^2 / \Lambda^2 \quad (\text{A.3})$$

where Λ is the fundamental scale. When $\varepsilon \rightarrow 0$, symmetry is restored. When $\varepsilon > 0$, symmetry is broken. The vacuum displacement is $v = \Lambda\sqrt{\varepsilon/\lambda}$.

The kinetic structure cannot presuppose a Lorentzian metric (which has not yet emerged). The most general quadratic kinetic term compatible with \mathbb{Z}_2 :

$$\mathcal{L} = \frac{1}{2}\alpha(\partial_t\varphi)^2 - \frac{1}{2}\beta(\nabla\varphi)^2 - V(\varphi) \quad (\text{A.4})$$

where α and β are pre-geometric substrate parameters (temporal and spatial stiffness respectively) and τ is a pre-geometric time parameter. The full action:

$$S[\varphi] = \int d\tau d^3x [\frac{1}{2}\alpha(\partial_t\varphi)^2 - \frac{1}{2}\beta(\nabla\varphi)^2 - V(\varphi)] \quad (\text{A.5})$$

A.3 The Broken Phase

The field settles into $\varphi = +v$ (without loss of generality). Write $\varphi = v + \chi$. Expanding to quadratic order:

$$S[\chi] = \int d\tau d^3x [\frac{1}{2}\alpha(\partial_t\chi)^2 - \frac{1}{2}\beta(\nabla\chi)^2 - \frac{1}{2} m^2\chi^2 + \dots] \quad (\text{A.6})$$

with effective mass:

$$m^2 = V''(v) = 2\mu^2 = 2\varepsilon\Lambda^2 \quad (\text{A.7})$$

The equation of motion yields propagation speed:

$$c^2 = \beta / \alpha \quad (\text{A.8})$$

Result A.1 (Emergence of c, KS-73). Perturbations on the broken vacuum propagate with speed $c = \sqrt{(\beta/\alpha)}$. c is not an input but an output of the broken phase.

Determined by the ratio of spatial to temporal stiffness of the pre-geometric substrate. Structurally identical to the emergence of the speed of sound in fluid mechanics: $c_s = \sqrt{(B/\rho)}$. ■

You did not put c into the action. c came out. The speed of light is not a law.

It is a consequence — of the ratio between how hard the substrate resists deformation in space versus time.

The same mathematics that gives you the speed of sound in water gives you the speed of light in vacuum. You already knew this intuitively. Sound has a speed because the medium has stiffness.

Light has a speed because the vacuum has stiffness. The universe is a medium. The break made it one.

A.4 What This Action Derives

Derived: The propagation speed c (equation A.8).

Derived: The effective mass of perturbations: $m^2 = 2\varepsilon\Lambda^2$ (equation A.7). The mass of excitations above the vacuum is set by ε .

Derived: The condensate energy density:

$$\rho_0 = |V(v)| = \mu^4 / (4\lambda) = \varepsilon^2\Lambda^4 / (4\lambda) \quad (\text{A.9})$$

The energy density of the background condensate — the Mode 0 content. It scales as ε^2 .

A.5 What This Action Does Not Derive

Not derived: The gravitational coupling G . The central honest admission of AP03.

For G to emerge from the action, perturbations χ must not only propagate on the condensate background but also source an effective metric — the backreaction of χ 's stress-energy on the background must produce an effective Einstein equation with a specific G .

The emergent gravity problem.

The analogue gravity programme derives an effective acoustic metric for perturbations: $g_{mv} \propto (\rho_0/c) \text{diag}(-c^2, 1, 1, 1)$. Perturbations propagate on this metric as though on a curved spacetime.

But — and this is critical — the metric is a fixed background. Not dynamical. Perturbations do not curve it. No Newton's constant in analogue gravity because there is no gravitational dynamics.

The background is rigid.

Going from “effective metric” to “effective G ” requires a dynamical mechanism by which the perturbation's own energy density modifies the acoustic metric.

Some approaches exist (Sakharov 1967 on induced gravity, Volovik 2003 on emergent gravity in superfluid helium-3), but none have been successfully completed for a simple scalar condensate of the type considered here.

Conjecture E-G (restated). Define $g_G \equiv G\Lambda^2$ (dimensionless). The conjecture is that g_G is determined by ε with the provisional scaling ansatz $c/G \propto \varepsilon^2$.

The dimensionful form $G \propto 1/(\rho_0 \cdot c)$ is physically motivated (stronger condensate \rightarrow stiffer vacuum \rightarrow weaker effective gravity) but dimensionally underspecified without a dimension-carrying coefficient tied to Λ .

A complete derivation must produce the exact coefficient. Not derived. The central open problem. ■

A.6 Summary of Appendix A

Established: (1) The \mathbb{Z}_2 -symmetric double-well action is the minimal pre-geometric theory with SSB. (2) In the broken phase, perturbations propagate with speed $c = \sqrt{(\beta/\alpha)}$. (3) The condensate energy density scales as ε^2 .

Conjectured but not derived: (4) $G \propto 1/(\rho_0 c)$. (5) $c/G \propto \varepsilon^2$. (6) $m_p \propto \varepsilon$.

Not addressed: (7) The substrate parameters α and β are introduced but not derived; c is parameterised but not predicted.

(8) The kinetic term presupposes a distinction between temporal and spatial coordinates (τ vs x) — a structural input, not an output. A truly pre-geometric formulation would derive this distinction. Acknowledged as a foundational limitation.

Appendix B. The \mathbb{Z}_2 Representation Theorem

Why exactly two modes

B.1 Statement

Theorem B.1. The group $\mathbb{Z}_2 = \{e, g\}$ where $g^2 = e$ has exactly two irreducible representations over the real (or complex) numbers: the trivial representation and the sign representation. ■

B.2 Proof

Let $\rho: \mathbb{Z}_2 \rightarrow GL(V)$ be a representation of \mathbb{Z}_2 on a vector space V . The generator g satisfies $g^2 = e$, so $\rho(g)^2 = I$ (the identity matrix).

Therefore $\rho(g)$ is an involution: its eigenvalues satisfy $\lambda^2 = 1$, giving $\lambda = +1$ or $\lambda = -1$.

The vector space V decomposes into eigenspaces:

$$V = V_+ \oplus V_- \quad (\text{B.1})$$

where:

V_+ : the +1 eigenspace. $\rho(g)v = +v$ for all $v \in V_+$. Vectors invariant under the \mathbb{Z}_2 action. The trivial representation.

V_- : the -1 eigenspace. $\rho(g)v = -v$ for all $v \in V_-$. Vectors that flip sign under the \mathbb{Z}_2 action. The sign representation.

Each eigenspace is itself an invariant subspace and carries an irreducible representation of \mathbb{Z}_2 . Since the only eigenvalues are +1 and -1, there are exactly two irreducible representations.

Any representation of \mathbb{Z}_2 decomposes into copies of these two. There is no third option.

This completes the proof. \square

B.3 Physical Interpretation

You have just read the proof. Two eigenvalues. Two sectors. No third option. That is not a choice. It is arithmetic.

The decomposition $V = V_+ \oplus V_-$ is the mathematical foundation of Claim E2. When the \mathbb{Z}_2 symmetry of the pre-state S breaks, all physical content sorts into one of two sectors:

V_+ (Mode 0): the sector invariant under the symmetry operation. Content unchanged by the break.

V_- (Mode 1): the sector that transforms non-trivially. Content maximally affected by the break.

Critical distinction: The theorem guarantees two sectors, not two particle species. Each sector may contain rich internal structure.

The entire Standard Model lives within Mode 1. The entire dark sector may live within Mode 0. The internal complexity of each sector is downstream of the binary split.

B.4 Why Not a Larger Group?

If the pre-state had a larger symmetry group (e.g., \mathbb{Z}_3 , $SO(3)$, $SU(2)$), the representation theory would admit more irreducible representations, and the break would produce more than two sectors.

More than two fundamental constants — more than two kinds of thing at the deepest level.

AP03's minimality postulate (E0) asserts that the universe arises from the simplest possible break.

Falsifiable: if the universe requires more than two fundamental sectors (Kill Switch 2), then the symmetry group is larger than \mathbb{Z}_2 and AP03's foundation fails.

Note: the Standard Model's gauge group $SU(3) \times SU(2) \times U(1)$ is the symmetry of the broken phase, not of the pre-state. How that gauge structure emerges within Mode 1 is a separate problem.

AP03 claims only that the deepest level of structure is binary (0 and 1). The rich internal structure of each mode is downstream.

Appendix C. The Horizon Analysis

Structural identity of origin and horizon

DEPENDENCY NOTE: This entire appendix is conditional on Conjecture E-G (that G is determined by ε , with provisional scaling ansatz $c/G \propto \varepsilon^2$).

If E-G is false, the analysis below is structurally interesting but not physically grounded. The results are presented as consequences of the conjecture, not as independent support for it.

See §4 and Appendix A, §A.5 for the status of E-G.

C.1 The Schwarzschild Geometry in the ε Architecture

The Schwarzschild metric describes the spacetime geometry around a spherically symmetric mass M :

$$ds^2 = -(1 - r_s/r)c^2 dt^2 + (1 - r_s/r)^{-1} dr^2 + r^2 d\Omega^2 \quad (\text{C.1})$$

where $r_s = 2GM/c^2$. Using the scaling relation $c/G \propto \varepsilon^2$:

$$r_s = 2GM/c^2 = 2M/(c \cdot c/G) \propto M/(c \cdot \varepsilon^2) \quad (\text{C.2})$$

C.2 The $\varepsilon \rightarrow 0$ Limit

As $\varepsilon \rightarrow 0$ (symmetry restoration), $r_s \rightarrow \infty$ for any nonzero M . The entire space is inside the horizon. No point is exterior. Mode 1 cannot escape Mode 0 anywhere. Propagation ceases.

The symmetric state.

Structural interpretation (not a derivation): The symmetric pre-state S is proposed as structurally analogous to the interior of a black hole that encompasses all of space.

The Big Bang is the moment when ε becomes nonzero and a finite r_s appears — the first exterior region, the first place where Mode 1 can outrun Mode 0. A reading that goes beyond what the mathematical limit alone establishes.

C.3 The $\varepsilon \rightarrow \infty$ Limit

As $\varepsilon \rightarrow \infty$ (maximal breaking), $r_s \rightarrow 0$ for any finite M . No event horizons form. Mode 1 completely dominates. Gravity becomes negligible.

A universe of pure propagation and no resistance — no structure, no binding, no stars, no atoms.

Interpretation: Both limits ($\varepsilon \rightarrow 0$ and $\varepsilon \rightarrow \infty$) are sterile. The first is all Mode 0 (no propagation). The second is all Mode 1 (no structure). A viable universe requires intermediate ε .

The architecture forces this without invoking the anthropic principle.

C.4 The Event Horizon as $\varepsilon = 0$ Surface

At the event horizon of any black hole, the metric coefficient $g_{tt} = -(1 - r_s/r)$ vanishes. The temporal component of the metric degenerates.

In the ε architecture: the local value of the breaking parameter has reached zero. The two modes are no longer distinguishable at this surface. Mode 0 and Mode 1 merge.

The identification of $g_{tt} = 0$ with “local $\varepsilon = 0$ ” is an interpretive step.

The Schwarzschild metric’s coordinate singularity at $r = r_s$ is removable (Eddington-Finkelstein, Kruskal-Szekeres); the physical content is that the escape velocity reaches c , not that spacetime structure degenerates.

The ε -architecture reading of this surface as “local symmetry restoration” is a structural analogy that goes beyond what the metric alone establishes.

Subject to this caveat: the event horizon is proposed as a local island of restored symmetry embedded in the globally broken phase.

C.5 Penrose Diagram Interpretation

In the Penrose diagram of a Schwarzschild black hole, the singularity is a spacelike surface in the future.

In the Penrose diagram of a Big Bang cosmology, the initial singularity is a spacelike surface in the past. Both are boundaries where the classical spacetime description breaks down.

In the ε architecture, both singularities represent $\varepsilon = 0$: the point where the break is fully closed (or has not yet opened).

The event horizon and the cosmological horizon are both marginal surfaces separating the $\varepsilon > 0$ region (broken phase) from the $\varepsilon = 0$ region (symmetric phase).

C.6 Hawking Radiation Revisited

Hawking (1975) showed that black holes radiate thermally with temperature $T_h = \hbar c^3 / (8\pi G M k^b)$. Using $c/G \propto \varepsilon^2$:

$$T_h \propto \varepsilon^2 \cdot c^2 / M \quad (\text{C.3})$$

For fixed M , the Hawking temperature increases with ε . The more strongly the symmetry is broken, the harder it is to maintain a local restoration.

In the limit $\varepsilon \rightarrow 0$, $T_h \rightarrow 0$: in the symmetric state, there is no radiation because there is no broken phase to leak into.

C.7 Limitations

The analysis is kinematic, not dynamic. The Schwarzschild geometry has been reinterpreted in the ε architecture but the Schwarzschild solution has not been derived from the pre-geometric action.

The analysis also assumes the scaling relation $c/G \propto \varepsilon^2$ without the exact coefficient, so all proportionalities are structural, not numerical.

The identification of the black hole interior with the symmetric pre-state is a structural analogy at this stage.

A rigorous identification requires showing that the quantum state of the black hole interior has the same symmetry properties as S . An open problem connected to the black hole information paradox. Not resolved here.

Appendix D. Experimental Signatures and Observational Tests

Making the kill switches operational

D.1 Overview

AP03's falsification conditions (§8) require operational experimental tests. The tests identified here range from currently feasible (using existing data) to future (requiring next-generation experiments).

D.2 Test 1: Correlated Variation of Dimensionless Couplings

Tests: Kill Switch 1.

Prediction: If c and G are conjugate, then α and α_G cannot vary independently over cosmological timescales.

Any variation in α must be accompanied by a correlated variation in α_G , with the correlation fixed by ε .

Observable: Quasar absorption spectra (many-multiplet method) constrain cosmological variation in α at the 10^{-6} level. BBN and lunar laser ranging constrain α_G . AP03 predicts these constraints are not independent. Uncorrelated variation falsifies the architecture.

Current status: Webb et al. (2011) reported marginal evidence for spatial variation in α from quasar spectra. No correlated α_G analysis has been performed. A feasible near-term test using existing datasets.

D.3 Test 2: Gravitational Coupling at the Planck Scale

Tests: Kill Switch 5 (indirect consistency at current stage).

Prediction: If $m_p \propto \epsilon$, then quantum gravity effects should onset at the Planck scale (not at a parametrically different scale).

Observable: Current table-top experiments testing gravity at sub-millimetre scales constrain low-energy deviations from Newtonian gravity.

These experiments do not directly probe Planck-scale onset, but they can exclude some extension classes that would imply large low-energy departures.

A direct KS5 test requires either (i) a derived low-energy signature of the ϵ -scaling hypothesis or (ii) an independent probe of the quantum-gravity threshold.

Current status: No deviations detected down to $\sim 50 \mu\text{m}$. Compatible with AP03 but not a direct test of KS5.

D.4 Test 3: The α - α_G Relationship

Tests: Kill Switch 6.

Prediction: If both α and α_G derive from ε , there should be a specific functional relationship between them.

AP03 does not yet predict the relationship (it requires the exact coefficient in $c/G \propto \varepsilon^2$), but once the coefficient is derived, a sharp numerical test becomes operational.

Current status: The enormous ratio $\alpha/\alpha_G(e) \sim 10^{43}$ is one of the great unexplained hierarchies in physics. If AP03 can derive it from ε , that would be a major result.

Becomes operational only when the build programme is further advanced.

D.5 Test 4: Dark Sector Energy Density

Tests: Kill Switch 3.

Prediction: If ε determines both c/G and the dark-to-visible ratio, then these two quantities are not independent. A specific ε that yields the observed c/G must also yield the observed $\sim 95:5$ ratio.

Observable: DESI, Euclid, and Vera Rubin Observatory will increasingly constrain dark sector composition. Gravitational wave standard sirens and neutron star mergers will constrain c/G .

If both measurements can be parameterised by a single ε , AP03 gains support.

Current status: Both measurement programmes are active. DESI first-year results (2024) show mild tension with Λ CDM. Becomes sharp when the build programme advances.

D.6 Test 5: Black Hole Information and Symmetry Restoration

Tests: Kill Switch 4.

Prediction: If the black hole interior is a local restoration of \mathbb{Z}_2 symmetry, then information that enters a black hole is not destroyed but returned to the symmetric (undifferentiated) state.

Information is neither lost nor preserved in its original form — it is symmetrised. The Hawking radiation should encode total energy and charge (Mode 0 quantum numbers) but not detailed Mode 1 structure.

Current status: The black hole information paradox is unresolved. AP03 offers a specific structural prediction (information is symmetrised) that is in principle testable against other proposals. A long-term theoretical test.

D.7 Summary of Experimental Programme

Test 1: Correlated α/α_G variation — KS1 — Near-term — Quasar spectra + BBN. Test 2: Planck scale gravity — KS5 — Ongoing — Sub-mm gravity experiments.

Test 3: α vs α_G relationship — KS6 — After build programme — Numerical prediction required. Test 4: Dark sector parameterisation — KS3 — After build programme — DESI, Euclid, Rubin.

Test 5: BH information structure — KS4 — Long-term — Theoretical consistency.

Tests 1 and 2 are operational now. Tests 3 and 4 become operational when the build programme advances. Test 5 is a long-term theoretical programme.

AP03 identifies the specific observations that will confirm or falsify it. The kill switches are real. They are not decorative.

Appendix E. Axiom Mapping

{S, B, R, C} ↔ AP03 Postulates

AP03 was written before the canonical axiom set {S, B, R, C} was formalised (AP20). The following mapping shows how AP03's postulates instantiate the four axioms.

Axiom S (Distinction exists) ↔ Postulate E0 (KS-71). S requires that something distinguishable exists. E0 specifies the minimal symmetry of the pre-state: \mathbb{Z}_2 , the simplest non-trivial group.

The pre-state S is the entity whose existence Axiom S asserts.

Axiom B (Exactly one break) ↔ Postulate E1. B requires exactly one irreducible symmetry-breaking event. E1 instantiates this as the spontaneous breaking $\mathbb{Z}_2 \rightarrow$ trivial with amplitude ε .

The minimality of \mathbb{Z}_2 ensures the break is irreducible: there is no intermediate subgroup.

Axiom R (The record persists) ↔ Broken vacuum. R requires that the break leave a persistent record.

In AP03, the broken vacuum with propagation speed $c = \sqrt{(\beta/\alpha)}$ and condensate energy density $\rho_0 = \varepsilon^2 \Lambda^4 / (4\lambda)$ is the persistent record.

The two sectors (Mode 0, Mode 1) persist because the broken vacuum is stable.

Axiom C (Constraint) ↔ Finiteness of c and positivity of G. C requires that all quantities remain bounded.

In AP03: c is finite (set by substrate ratio β/α); $G > 0$ (conjectured, but if it holds, bounded by ε and Λ); ε itself is small and bounded.

Note: AP03's postulates are more specific than {S, B, R, C} — they choose a particular symmetry group (\mathbb{Z}_2) and a particular mechanism (SSB of a scalar field).

The axioms {S, B, R, C} are the abstract structure; AP03 is a specific instantiation.

Conditionality Footer

Conditional on: Nothing. AP03 is logically independent of all other Artist's Proofs. Its two postulates (E0/KS-71, E1) are self-contained.

**Conditioned upon by: AP24 (The Residual) extends AP03's conjugacy conjecture to the full constant set. AP08 (The Identity) derives the EFEs whose coupling constant G AP03 conjectures about.

AP05 (The Break) derives Lorentzian spacetime, which AP03's broken phase instantiates. AP17 (The Room) relates 0-pole/1-pole structure to Mode 0/Mode 1. All structural relationships, not formal dependencies.**

Central open problem: Derivation of G from the pre-geometric action (Debt D1). Until resolved, KS-74 (E-G), KS-75 (E-Identity), KS-76 (E-Hawking), and KS-77 (E5) remain conjectures.

Corpus Editor's Note: See note at §0. D1. The structural forcing argument (AP20) proves G must be determined by ϵ . The scaling relation has been derived (Edition 03/Paper E) and verified.

The debt is reduced from "is G determined?" to "can the explicit formula be derived purely from axioms without importing the Sakharov mechanism?"

Foundational limitation: The kinetic term presupposes temporal/spatial anisotropy ($\alpha \neq \beta$). A fully pre-geometric formulation would derive this distinction. Acknowledged and unresolved.

Status: Publication-ready. Edition 03.3.

KS numbers assigned: KS-71 (E0), KS-72 (E2), KS-73 (E3/Result A.1), KS-74 (E-G), KS-75 (E-Identity), KS-76 (E-Hawking), KS-77 (E5).

Outstanding debts: D1 (G derivation), D2 (substrate parameters), D3 (dark sector functional form), D4 (temporal/spatial distinction).

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