Records and Responses in the World

A derived fine-structure boundary, certified confinement gaps, and registered discriminators for a finite record substrate

David Elliman
Neuro-Symbolic Ltd
dave@neusym.ai
https://neusym.ai

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Abstract

A companion paper [1] proved five dressing-blind theorems for monitored quantum instruments: observables split into *records* (exact, diagonal, unrenormalisable ledger entries) and *responses* (dressed, scheme-dependent meter readings), and no interaction cloud can move a bill. This paper reports what happens when a research programme takes that split seriously as physics. Working over a finite error-corrected substrate whose record layer was compressed and certified in [2], we present, with every claim tier-labelled and every number re-derivable from a named self-checking program: (i) a *derivation* of the fine-structure boundary, $\alpha_{\mathrm{FW}}^{-1} = 137.035999107$, from a counting identity plus a computed dressing branch, landing on the *contested* side of the 5.5σ caesium–rubidium recoil disagreement and -3.9σ from the electron-anomaly channel through an unmodified perturbative series—next-generation recoil metrology adjudicates a stake the framework can no longer move; (ii) an electroweak one-anchor route reduced to three response legs, with a registered top mass $M_t = 172.69$ GeV, a Higgs boundary narrowed to $\lambda(M_{\mathrm{Pl}}) = -C\alpha_0$ with $C \in \{1, 2\}$, and a vacuum-value candidate $v = \frac{15}{16}\,\alpha_0^8 M_{\mathrm{Pl}}/\sqrt{\lambda_{\mathrm{eff}}}$ whose distance to lock is fully quantified (the experimental endpoint is $\delta m_H \lesssim 55$ MeV, the same HL-LHC measurement two independent parts of the programme bottom out on); (iii) a confinement statement pushed to certificate grade: the mirror-sector gap of the substrate's chiral embedding carries rigorous coupling-uniform floors 2.63–3.00 across an exact volume ladder, with a conditional infinite-volume floor $\Delta_\infty \geq 2.35$ and exactly two named limit legs remaining; and (iv) a gravitational and transport response layer—black-hole thermodynamics and greybody structure reproduced with superradiance reread as unbilled response, a zero-parameter substrate-noise fingerprint $\Gamma = D\,(2\pi/L)^2$ at fixed $D = 1.20 \times 10^{-7}\,\mathrm{m^2\,s^{-1}}$, and quantified nulls protecting the framework from its own most convenient stories. Five predictions are pre-registered with timestamps; eleven branches the framework killed itself are listed with dates. The paper closes with a falsification map: which experiment ends which claim.

1 Introduction: bills and meters

The companion paper [1] studied a class of monitored quantum systems in which every observable is exactly one of two kinds. *Records* are the latched, pointer-diagonal entries: a detector click, a stored syndrome, an inscription that later dynamics can dress but never rewrite. *Responses* are everything else: propagators, susceptibilities, couplings—the meter readings taken between inscriptions. Five theorems (T1–T5 there) make the split operational: record statistics are classical and factorise at diagonal Born weights; dressing clouds renormalise responses by Franck–Condon overlaps while leaving the record algebra invariant as an operator identity; a record's LSZ [3] residue is exactly 1; latch-time gauges wash out of records; and normal-ordering constants belong to the Euclidean (contact) side of the split [4]. The language of pointer records is standard decoherence language [5]; the additional step here is to make the record/response split an executable accounting rule. In banking terms: bills and meters. Bills cannot be renormalised; meters always are.

That paper was deliberately physics-free. This one is the physics. The programme it reports models physical law as the bookkeeping of a finite, error-corrected record substrate—a fixed cell complex with lattice constant $a_0 = 0.59494$ fm whose stabiliser record layer was compressed to an executable grammar and certified in [2]. On such a substrate the record/response split is not a philosophical gloss; it is a calculational instruction with teeth:

- **Integer-grade claims live on the record side.** Counts of channels, codewords, and conserved totals are exact or wrong. They can be killed by a single clean measurement and cannot be tuned.
- **Measured constants live on the response side.** They are dressed readings of record-grade counts, carrying computable branch corrections, scheme labels, and uncertainty bands.
- **Every claim must say which side it lives on.** Confusing the layers is how frameworks die of their own bookkeeping.

This paper collects the programme's present confrontation layer under that discipline. It contains one *derivation* (Section 3), several *certificates* (Section 5), a set of *registered candidates* with quantified distances to promotion (Section 4), a *response atlas* of gravitational, transport, and high-energy nulls (Section 6), and the registered/killed ledger with a falsification map (Sections 7–8). Nothing here is folklore: every number quoted is an assertion of a named self-checking program (Appendix A), and every claim carries one of six tier labels defined in Appendix B. Readers are owed one warning up front: three of the six sections end in open, named theorems. The programme's habit is to publish its gaps with the same care as its results, because the gaps are where it can still die.

2 The substrate in five lines

For this paper the substrate can be taken as a black box with five properties. (1) It is a finite 3+1–dimensional cell complex (tetrahedral–cubic honeycomb class) with a *physical* lattice constant $a_0 = 0.59494$ fm; there is no $a \to 0$ limit to take, so every "continuum" question becomes a finite-volume/finite-cutoff uniformity question. (2) Its record layer is a stabiliser code; inscriptions are syndrome latches, and the record grammar—the full set of allowed inscriptions and their statistics—was compressed to an executable certificate in [2]. (3) Gauge fields live on links and matter on vertices in the Kogut–Susskind Hamiltonian sense [6]; the Standard-Model embedding uses a symmetric-mass-generation (SMG) construction whose mirror sector must gap out for the low-energy theory to be chiral. (4) Dressed constants are response readings of record counts: the prototype is the fine-structure boundary, a count of 137 channels read through a computed dressing branch (Section 3). (5) Decohered records are classical exactly, by T1–T3 of [1], which is why a substrate that is "alive" at the response layer still presents, at the record layer, the static ledger a bank statement does.

3 QED: the boundary derived, and a stake on the unpopular side

3.1 From count to constant

At the record layer the electromagnetic sector of the substrate has an integer in it: 137 interface channels. That is a bill—exact or wrong. The measured fine-structure constant is not that integer; it is a *response reading* of it,

$$\alpha^{-1}(0) \;=\; 137 \;+\; \delta_{\text{dress}}, \tag{1}$$

where δ_{dress} is the dressing branch: the computable price of reading a record-grade count through the substrate's own service dynamics. For most of the programme's history δ_{dress} was constrained by census (which combinations of substrate constants could appear) but not derived. That changed in the present cycle. The derivation chain—an endpoint-current identity, a single-contact term, and the second-order kernel K_2 of the service map, assembled Euclideanly exactly as T5 of the companion paper instructs—fixes the branch coefficient with no free choices. An intermediate one-contact evaluation lands at 137.036013; the full K_2 chain gives the boundary

$$\boxed{\alpha_{\text{FW}}^{-1} \;=\; 137.035999107} \tag{2}$$

(nine significant decimals quoted; the certification program carries 137.035999106904).

Status: derived. The named residual is the K_2-chain's own uncertainty budget—what moves Eq. (2) at the 10^{-8} level—which is the direct analogue of the electroweak theory-band decomposition of Section 4.

3.2 The confrontation: a measurement sector at war with itself

Equation (2) walks into a metrology sector that currently disagrees with itself. The three sharpest determinations of α^{-1} are the caesium recoil measurement [7], the rubidium recoil measurement [8], and the electron magnetic anomaly combined with the Standard-Model series [9]:

channel	α^{-1}	pull of α_{FW}^{-1}
Cs recoil (2018)	137.035 999 046 (27)	$+2.3\sigma$
Rb recoil (2020)	137.035 999 206 (11)	-9.0σ
a_e + SM (2023)	137.035 999 166 (15)	-3.9σ

The two recoil experiments disagree with each other by 5.5σ; the Birge ratio of the ensemble is 5.5. The CODATA-2022 adjustment [10] sits only $+0.7\sigma$ from the a_e channel, while Eq. (2) sits -3.9σ from that same channel. No theoretical stake can be "confirmed" by data that are internally inconsistent at five sigma; what a theory can do is put a value on the table *before* the war resolves, and accept that the resolution judges it.

Two features of this stake deserve emphasis because they are the no-fitting-payoff signature in its strongest form. First, the *direction*: an earlier residual census had registered (not adopted) a composite on the rubidium side of the war, one sigma from the most comfortable cluster. The subsequent derivation—with no freedom left—moved the boundary *past* the a_e value onto the contested caesium side. A framework fitting for comfort would have gone the other way; the census stake is retired to the killed ledger (Section 7) with the supersession recorded. Second, the *rigidity*: because the record integer cannot be renormalised (T2–T3 of [1]) and the branch is now derived, the framework no longer owns a dial. If next-generation recoil metrology settles on the rubidium side, the boundary is wrong by nine sigma and Eq. (1) dies as stated.

Status: derived, externally clocked. The clock is the Rb/Cs war's resolution; the framework awaits it as a third party with a published value.

3.3 Process-level nulls

Three further statements close the QED process level. (1) *The a_e channel is carried, not explained away*: the substrate's closed QED interface means the Kinoshita-class perturbative series relating

α to a_e is *unmodified*; the -3.9σ confrontation above is therefore live and cannot be absorbed by new substrate physics at this order. (2) *The Thomson limit is exact*: the unit endpoint residue (T3) plus Ward identity force low-energy Compton scattering onto the boundary α with no correction; any confirmed deviation of the Thomson limit from Eq. (2) is a falsifier. (3) *Standard running is inherited*: evolving the boundary to the Z pole gives $\alpha^{-1}(M_Z) = 128.939$ (on-shell effective coupling), -0.5σ from the PDG-class value 128.946(15) [11].

4 Electroweak: a one-anchor route with three response legs, every distance quantified

The electroweak sector of the programme reduced, over the last development cycle, to a one-anchor route—the strong-sector scale plus record integers—feeding three response legs: the top Yukawa channel, the Higgs boundary, and the vacuum value v. The route is not locked. What distinguishes the present state is that every remaining distance is now a number with a named owner.

4.1 The top channel: a registered $M_t = 172.69$ GeV

The record/response split makes one parameter-free prediction about the top quark immediately: the *pole* (response) Yukawa must sit *below* the record-grade coupling, $y_{\text{pole}} \leq y_{\text{record}}$, because dressing can only shed weight from the residue (T3). The measured split sits 5.3σ below unity: the sign theorem passes where it could have failed.

The magnitude is a counting question: how many dressing contacts does the top channel bill? The natural unit is $\alpha_0/2\pi$ per contact. A census executed three integer hypotheses against data: $N = 1$ (one per web analogue) is dead at 4.6σ; $N = 4$ (one per flip) is disfavoured at 2.5σ; and a pinned-combination count—one contact per inscription endpoint *minus one* for the latched combination that is record-grade and therefore unbillable, $N = 8 - 1 = 7$—is adopted *by derivation*, the same $2^k - 1$ arithmetic that fixes the $31 = 32 - 1$ structure elsewhere in the framework's constant ledger. The result is a registered top mass,

$$M_t \;=\; 172.69 \text{ GeV } (\pm 12 \text{ MeV conventionclause}), \tag{3}$$

sitting -0.4σ from the current world average, with the $N = 8$ rival at 172.49 GeV. An FCC-ee-class M_t measurement separates the two counts at the tens-of-sigma level.

Status: derived-conditional (the pinned-combination lemma is stated, its promotion to a standalone theorem is a named open item); externally clocked by FCC-ee. Honesty note: today's central value marginally favours the killed *rival—recorded, because a programme that only reports flattering intervals is not doing science.*

4.2 The Higgs boundary: $C \in \{1, 2\}$ and one measurement that decides three things

The substrate ties the Planck-scale quartic to the fine-structure constant:

$$\lambda(M_{\text{Pl}}) \;=\; -\,C\,\alpha_0, \qquad C \in \mathbb{Z}. \tag{4}$$

Running the measured Higgs sector up with the public next-to-next-to-leading-order machinery [12, 13] gives $-\lambda(M_{\text{Pl}})/\alpha_0 = 1.38 \pm 0.42$: the boundary integers $C = 0, 3, 4$ are dead at 3.3, 3.9, and 6.2σ respectively, while $C = 1$ and $C = 2$ survive. A balanced-pairing count (three pairings of the quartic's legs, two of them balanced) derives $C = 2$ conditionally on a named exchange premise; notably $C = 2$ fits today's central value *worse* than $C = 1$—the derivation again declined to chase comfort.

The boundary was then stress-tested end-to-end at modern precision using the tadpole-free scheme of the SMDR code [14] (a seven-point input campaign in M_t, m_H, α_s; three-loop effective-potential grade [15]): the deployed linearised map's slopes reproduce to 1–3%, the central boundary shifts by $+3.4 \times 10^{-4}$—inside the assigned scheme band—and no pull in the C-ladder moves by more than 0.16σ. The surviving integers translate into top-mass windows

$$m_t(C{=}1) = 172.15 \pm 0.38 \text{ GeV}, \qquad m_t(C{=}2) = 173.25 \pm 0.38 \text{ GeV}, \tag{5}$$

which straddle the registered $M_t = 172.69$ of Section 4.1. One FCC-ee-class top-mass measurement therefore adjudicates the dressing-count split *and* the boundary integer simultaneously.

Status: derived-conditional ($C = 2$; the exchange premise is the named gap), with $C \in \{1, 2\}$ data-live; externally clocked by FCC-ee-class m_t and by $\delta\alpha_s$.

4.3 The vacuum value: a registered 15/16 and the full price list to lock

The third leg is the electroweak scale itself. The substrate's k=8 filled-byte transition supplies the seed combination $\alpha_0^8 M_{\rm Pl}$, and the chain

$$v \;=\; C_v \, \frac{\alpha_0^8 \, M_{\rm Pl}}{\sqrt{\lambda_{\rm eff}}}, \qquad \lambda_{\rm eff} = \lambda(M_t) + \Delta\lambda_{\rm CW}, \tag{6}$$

lands +6.5% high at $C_v = 1$: the raw public chain is *not viable*, and the boundary operator cannot absorb the excess (the required m_H would be ~ 86 experimental sigma away). The missing operator is multiplicative and sharply sized: $C_v = 0.9386 \pm 0.0052$. The framework owns a derived operator family of exactly this shape—busy projectors $\mathrm{Tr}[P_{\rm busy}]/2^n = 1 - 2^{-n}$, with the depth-6 member 63/64 already forced in the acoustic sector—and at the quartic codebook's own logical depth $k = 4$ the family gives

$$C_v^{\rm cand} \;=\; \frac{15}{16} \;=\; 0.9375 \qquad (-0.2\sigma \text{ of the required value}), \tag{7}$$

the unique family member inside the window (7/8 and 31/32 are tens of sigma out). An all-rationals census is reported as *uninformative*—near 0.94 irreducible fractions are dense at the band scale—so the candidate's weight rests entirely on the operator family, not on numerology. If adopted, the Sirlin pole transfer [16] in the frozen scheme ($\alpha^{-1}(M_Z) = 128.9388$, $s_W^2 = 0.22334$, $\Delta r = 0.03643$) gives $M_W = 80.265$, $M_Z = 91.077$ GeV: both 0.12% low, and—this is the single-factor lemma—*identically* so, because at frozen scheme both poles are linear in v. The frightening-looking "$-55\sigma_{\rm exp}$" on M_Z (the experimental pole is known to 2 MeV) is the *same statement* as "-0.2σ of the C_v band"; the pole layer adds no independent tension.

The distance to lock is now a price list rather than a hope:

- **The band is theory-dominated**: 94% of the variance of σ_{C_v} is the mixed-order Coleman–Weinberg prescription, not experiment. Staged: fixing the CW order takes the band from 5.5×10^{-3} to 1.3×10^{-3}; SMDR-grade matching [14] to 8.1×10^{-4}, at which point it is m_H-dominated.
- **The experimental endpoint is $\delta m_H \leq 55$ MeV** for the canonical 4×10^{-4} tolerance—within 4% of the 57 MeV floor that the *independent* electroweak theory-band programme bottoms out on. Two separate precision programmes converge on the same HL-LHC measurement.
- **The promotion theorem carries a new clause**: the bare-versus-dressed convention of the α_0^8 seed is a discrete $+2.1 \times 10^{-3}$ lever on the required C_v—invisible today, 5.3σ at the target tolerance. The depth-4 sector-coupling theorem must therefore derive the seed's dressing state, not only the 15/16.

- **Dressing corrections are degenerate today and registered as a discriminator**: 15/16-exact and $15/16\,(1+\varepsilon)$ for ε in the canonical coefficient family ($\alpha_0/6$, $\alpha_0/2\pi$, ...) all sit within 0.25σ of the required value at the current band. One of them lands within 10^{-6} of the central value; the programme records this explicitly as *spurious precision*—at a 5×10^{-3} band such exactness carries no information—and defers it to the target band, where the $\alpha_0/6$-class dressing separates from exact at 3σ. Register, then derive: the QED sector (Section 3) is the cautionary precedent in both directions.

Status: registered candidate; NOT adopted. Promotion = the depth-4 busy-exposure sector-coupling theorem (with the seed-dressing clause) + the CW-order computation; the experimental clock is HL-LHC-class δm_H.

5 Confinement with certificates: the mirror gap

A chiral Standard Model on a finite substrate lives or dies by symmetric mass generation: the mirror partners must acquire a gap from gauge dynamics alone, uniformly in volume, representation cutoff, and coupling. On the substrate's strip geometry this is the statement

$$\inf_{L,\ \mathrm{cut},\ \beta} \Delta_{\mathrm{mirror}} \;>\; 0, \tag{8}$$

a lattice-gauge question in the Wilson/Kogut–Susskind setting [6, 17] that the programme has been climbing for months through exact diagonalisation ladders (state spaces 3,321 → 141,435 → 6,042,483). The route: a rigorous reduction (the inf-statement is equivalent to pure-gauge bracket positivity—confinement—on the strip, because the matter theory's vacuum sector *is* the pure-gauge theory); a rigorous strong-coupling certificate for $\beta < 1.457$; measured defect-locality decay (the Combes–Thomas signature that makes the volume axis geometrically convergent); and, until recently, exactly one unproven leg: coupling-uniformity of the pure-gauge strip gap on the window $1.457 < \beta < 6$.

That leg is now closed at fixed truncation by a certificate whose structure deserves stating because it is elementary and reusable. On a fixed sector the Kogut–Susskind Hamiltonian is a *linear pencil* in $(1/\beta, \beta)$,

$$H(\beta) \;=\; \frac{1}{\beta}\,E \;+\; \beta\,M, \tag{9}$$

with E the diagonal electric Casimir operator and M the Wilson magnetic operator. Weyl's eigenvalue inequalities [18] then give the gap a Lipschitz field whose constants are read off the operator itself,

$$|\Delta(\beta') - \Delta(\beta)| \;\le\; \left|\tfrac{1}{\beta'} - \tfrac{1}{\beta}\right| \mathrm{spread}(E) \;+\; |\beta' - \beta|\,\mathrm{spread}(M), \tag{10}$$

so a *finite* grid of exact diagonalisations bounds the infimum over the *continuum* of couplings. The pure-gauge strip sector is per-plaquette flux ($\dim 3^N$), proven exact against the full matter build, so the ladder reaches $N = 8$ plaquettes on a desktop. The certified floors:

	$N{=}2$	$N{=}3$	$N{=}4$	$N{=}6$	$N{=}8$	$N{=}2$	$N{=}3$
	minimal cut					doubled cut	
$\inf_{\beta\in[1.457,6]} \Delta \ge$	3.003	2.915	2.822	2.708	2.631	2.282	2.250

The volume increments contract along the equal-step tail $\{4, 6, 8\}$ at every grid coupling (worst ratio $r = 0.559$, at the weak-coupling end where a shorter ladder had *not* yet contracted—that negative is kept on the record), giving a conditional infinite-volume floor

$$\Delta_\infty \;\ge\; 2.35 \tag{11}$$

under the named Combes–Thomas continuation premise. On the cutoff axis, doubling the representation content moves the gap by up to 43% at weak coupling (higher representations matter exactly where the magnetic term dominates—an early draft asserted small drift and was killed by its own data), but positivity is *certified at both cuts*, which is what Eq. (8) needs. What remains of the inf-statement is exactly two limit legs—$N \to \infty$ with a quantified geometric tail, cut $\to \infty$ with two-point evidence—and no coupling-window mystery anywhere.

Beyond the gap itself, the programme froze a fingerprint protocol for the substrate's non-cubic geometry (four admissible discriminants: an averaged ℓ=4 anisotropy, a junction excess, glueball ratios, and a roughening signature; kill rules and outcome space fixed before compute; the numeric freeze staged to follow instrument validation), so that when production-grade spectroscopy runs, the question "does the honeycomb differ measurably from a cubic lattice?" will be answered against commitments rather than retrodictions.

Status: fixed-truncation floors: rigorous (eigensolver backward error budgeted); Δ_∞: derived-conditional, premise named; the two limit legs and the fingerprint confrontation: open, named.

6 Gravitational, transport, and high-energy responses

The response layer of the substrate is where most of its physics lives, and most of what it earns there at present are *nulls*: quantitative statements that protect the framework from its own most convenient stories. We collect the four arenas.

6.1 Black holes as service-graph thermodynamics

The substrate reproduces the standard horizon thermodynamics [19, 20] where it must: Kerr and Reissner–Nordström horizon maps satisfy the first law by finite differences to 10^{-5}, with extremality appearing as a service stall. Three quantitative refinements are the framework's own:

- **Superradiance is unbilled response.** The scattering identity $1 - |R|^2 = (k_H/k_\infty)|T|^2$ is verified numerically to 10^{-9} across the superradiant window; amplification extracts rotational free energy without writing a record—gain without a bill—consistent with the general treatment of rotational superradiance [21].
- **Species structure.** The Dirac greybody channel, computed from the standard tortoise-coordinate potential, gives $\sigma_f/A_H = 0.135$, within 8% of the low-frequency fermion benchmark 1/8.
- **Absolute flux.** The framework's candidate coefficient $(10/27)\,\alpha_0$ evaluates to 0.997 of the Stefan–Hawking normalisation; evaporation clocks follow ($\tau/t_{\text{universe}} = 1.5 \times 10^{57}$ for a solar mass; ~ 24 for a 5×10^{14} g relic).
- **A clean anti-story.** "No fast scrambling without a nonlocal service graph": with the substrate's own transport coefficient (below), the diffusive time exceeds the fast-scrambling conjecture's time by a factor 2.1×10^{16} at a solar mass. The substrate, as built, is *not* a fast scrambler, and the programme registers that as a null rather than borrowing the fashionable property.

Status: consistency layer + quantified nulls; the absolute-flux coefficient is candidate-grade; the black-hole echo story was rejected *before registration as non-discriminating (Section 7).*

6.2 A zero-parameter noise fingerprint

The substrate's service dynamics defines an internal diffusion constant with no free parameters, $D_{\text{int}} = 1.20 \times 10^{-7}\ \text{m}^2\,\text{s}^{-1}$ (set by a_0 and the QCD clock). The transport apparatus built on it is certified against the fluctuation–dissipation theorem [22, 23] at the 10^{-12} level, with the order-of-limits protection computed exactly: static susceptibilities are D-blind (they cannot see the substrate), while the noise-power corner frequency reads D directly. The resulting laboratory fingerprint is a Lorentzian family with corner

$$\Gamma \;=\; D_{\text{int}} \left(\frac{2\pi}{L}\right)^2 \;=\; \begin{cases} 0.76\ \text{Hz} & L = 1\ \text{mm}, \\ 7.6 \times 10^5\ \text{Hz} & L = 1\ \mu\text{m}, \end{cases} \tag{12}$$

with the $1/L^2$ scaling as the kill test and the *amplitude* deliberately unclaimed (the coupling/billing theorem is a named open item; the fingerprint is falsifiable-only). The same coefficient closes a cosmological escape hatch: at halo scales the relaxation rate is $\Gamma(10\ \text{kpc}) = 2.2 \times 10^{-29}\, H_0$—halos cannot read the microscopic D, so no collective substrate relaxation can be invoked to rescue or fake dark-sector dynamics.

Status: apparatus certified; fingerprint registered (falsifiable-only); amplitude theorem open, named.

6.3 Trans-Λ_{QCD} quanta without a UV vacuum

TeV-scale quanta on a femtometre-cutoff substrate sound like a contradiction; the resolution is that they are *null chains of service events*, not excitations of a UV oscillator vacuum. Two theorem-grade legs anchor this. The detector-response leg: for hard detection kernels the chain reproduces textbook QED rates *exactly* (a GNS isometry argument, any subdivision, any weights), while soft kernels acquire Poisson sidebands with computed envelopes—and the construction carries an absurdly sharp built-in falsifier: the probability of an N-fold coincident misread of a single chain is e^{-N}-suppressed to the point that one confirmed anomalous coincidence event ($\sim 10^{-1564}$ under the null) ends the model. The finite-density leg: refraction is unbilled response phase and opacity is the one-episode Beer–Lambert law; the chain's link time is $\tau_{\text{link}} = 1.98 \times 10^{-24}$ s and its formation length $\ell_{\text{link}} = 0.59$ fm sits five or more orders below every medium's photon formation length, so no laboratory or astrophysical medium probes the chain scale; the in-medium stakes reproduce ($\Delta v/v \sim -7 \times 10^{-53}$ at 1 TeV in the intergalactic medium; pair-production threshold ~ 412 TeV).

Status: two legs theorem-grade at stated premises; the falsifiers are the point.

6.4 Weak lensing: a fork that keeps surviving

At galactic scales the substrate predicts a *metric-branch* radial-acceleration behaviour whose discriminating regime is the lowest accelerations. Against the KiDS-1000 lensing RAR [24] the metric branch is preferred over a finite-halo (HOD) rival by a BIC gap of +12.0; loading the comparison with the full catalogue-level nuisance stack (two-halo term, satellites, miscentring at literature priors, on both branches) *raises* the gap to +12.6—no nuisance rescues the rival. Against the joint kinematic+lensing profiles of [25], the low-acceleration extension above the registered edge retains a square-root-like logarithmic slope $s = 0.58 \pm 0.06$. The below-edge tail remains inconclusive in the current desk-data run, so the decisive-data specification is registered separately: three clean points at $\log_{10} g_{\text{bar}} \leq -14.2$ with per-point scatter ≤ 0.10 dex settle the fork at three sigma.

Status: fork survival at binned grade, nuisance-robust; the full-catalogue campaign and the decisive deep points are the named next instruments.

7 The ledger: registered, killed, and the discipline

7.1 Pre-registered predictions

Five predictions are frozen with public timestamps; each states which layer it lives on:

#	prediction (layer)	reference
1	Dark energy $w_0 = -27/28$, $w_a = -1/28$; $w(a) = -1 + a/28$ (record: clock ledger)	[26]
2	Sterile-neutrino X-ray line at $E_\gamma \approx 8.8$ keV from a 17.7 keV state—and *not* the 3.5 keV line (record: dark-sector byte)	[27]
3	Primordial tensor null $r_{\text{linear}} = 0$ with a scalar-induced floor $r \in [2 \times 10^{-9}, 2 \times 10^{-8}]$ (record: printer alphabet)	[28]
4	K04 fossil defects are substrate-pinned, not mobile halo dark matter (record: pinning)	[29]
5	$G = 6.674311 \times 10^{-11}$ $\text{m}^3\text{kg}^{-1}\text{s}^{-2}$ from the proton mass (record: anchor chain)	[30]

Registered inside the programme (external clocks named, not yet separately timestamped): $M_t = 172.69$ GeV (Section 4.1); the m_t triangle $\{172.15, 173.25\}$ (Section 4.2); the $C_v = 15/16$ candidate with its lock price list (Section 4.3); the substrate-noise fingerprint (falsifiable-only); the deep-lensing decisive-data specification; and the QCD fingerprint protocol with kill rules frozen pre-compute (Section 5).

7.2 The killed list (selected)

A programme's credibility lives in what it has executed of its own. With dates in the development record: the Higgs boundary counts $C = 4$ (dead 6.2σ) and $C = 3$ (3.9σ), both also killed structurally by the later pairing derivation; the top-channel count $N = 1$ (4.6σ); the φ^* DC-equilibrium branch (retracted by a latch-clause theorem); the tensor birth-kick channel ($r \sim 10^{-68}$: the framework's own inflationary consolation prize, computed away); the black-hole echo pre-registration (*rejected before registration* as non-discriminating against general relativity); the reading of K04 fossils as mobile halo dark matter (the framework forbids its own most convenient dark-matter story—that is prediction #4 above); the morning QED census stake 137.035999217 (superseded *the same day* by the derivation landing on the opposite side of the recoil war); and a "13× theory-band shrink" gloss, superseded by an honest decomposition showing theory alone yields 6.9× with the rest hostage to δm_H.

7.3 The discipline, briefly

Three working rules generated the above and are worth stating because they are checkable in the artefacts. *Register, then derive*: stakes are placed with trials accounted before derivations exist; when the derivation arrives it may move the stake (QED did, away from comfort) and the supersession is recorded, never silently. *No-fitting-payoff*: three independent times in this cycle the framework's derived value fit the data *worse* than a live rival (M_t today vs. the killed N=8; C=2 vs. C=1; the QED stake-flip)—exactly what one expects from derivations and not from fits. *Certificates over scans*: where a claim can be made rigorous at fixed truncation (Section 5), a three-line theorem plus a finite grid replaces an open-ended parameter scan.

8 The falsification map

claim	dies if	decisive instrument
QED boundary $\alpha_{\rm FW}^{-1}$ (2)	recoil war resolves Rb-side (9σ)	next-gen atom-recoil metrology
Thomson exactness	any confirmed low-energy deviation from (2)	precision Compton/Thomson
$M_t = 172.69$ (count N=7)	pole mass at 172.49 (N=8) or elsewhere	FCC-ee-class m_t
Higgs boundary $C \in \{1, 2\}$	$-\lambda(M_{\rm Pl})/\alpha_0 \notin \{1, 2\}$ at 5σ	FCC-ee m_t + lattice α_s + HL-LHC m_H
$C_v = 15/16$ candidate	required C_v excludes 15/16 at target band	CW-order theorem + HL-LHC $\delta m_H \le 55$ MeV
Mirror-gap route	any certified floor closing under the two limit legs	larger-N/cut certificates (in-house)
Dark energy $w(a) = -1 + a/28$	DESI/Euclid exclude $(w_0, w_a) = (-27/28, -1/28)$	Stage-IV BAO/SNe
Tensor null	$r \ge 10^{-3}$ detected	LiteBIRD / CMB-S4
Sterile byte	no line at ≈ 8.8 keV at forecast depth (or a confirmed 3.5 keV sterile line)	X-ray microcalorimeters
G lock	next-generation G at ≤ 15 ppm off 6.674311	precision G experiments
Noise fingerprint	corner $\ne D(2\pi/L)^2$ scaling	cryogenic $1/L^2$ noise scan
Lensing fork	HOD branch wins the deep points	KiDS-class catalogue + $\log g_{\rm bar} \le -14.2$ points
Trans-Λ chains	one confirmed N-fold anomalous coincidence	any large detector array

9 Concluding remark

The companion paper ended by noting that its theorems were instruments awaiting a substrate. This paper is the substrate answering. The pattern of the answer is perhaps its most scientific feature: one constant derived and immediately staked on the unpopular side of a live experimental dispute; an electroweak sector that refuses to call itself locked and instead publishes its price list; a confinement statement that converted a folklore expectation into certificates with two named legs remaining; and a response layer that spends most of its energy building nulls against the framework's own convenience. Bills that cannot be moved, meters that must be priced, and a standing invitation to the experiments that can end it.

Reproducibility. Every quantitative claim in this paper is an assertion of a self-checking program listed in Appendix A; each exits with status 0 only if all its checks pass, and each was at exit 0 at the repository state this paper describes.

A Certification programs

One program per claim cluster (Python, NumPy/SciPy only; names as in the programme repository).

- Section 3: `qed_process_response_precision_gate.py` (K_2-chain boundary and channel pulls); `qed_metrology_fork_resolution_gate.py` (Cs/Rb/a_e table, Birge analysis); `qed_process_level_closeout_gate.py` (stake-flip record, Thomson null, running at -0.5σ).

- Section 4: `top_channel_dressing_split_registration_gate.py` (sign theorem, census, M_t registration); `ew_h_leg_balanced_pair_derivation_gate.py` and `ew_h_leg_precision_smdr_gate.py` (C ladder and SMDR stress test); `v_map_public_scheme_rerun.py` (C_v sizing and family census); `ew_fixed_scheme_pole_calculation.py` (frozen pole scheme); `ew_v_leg_lock_conditions_gate.py` (single-factor lemma, band decomposition, lock price list).
- Section 5: `smg_mirror_gap_uniformity_gate.py` (reduction and volume/locality evidence); `smg_strip_puregauge_beta_certificate_gate.py` (Weyl-pencil floors, tail contraction, two-cut certificates); and the frozen protocol in `recent_papers/fi_qcd_fingerprint_prereg/`.
- Section 6: `bh_response_template_gate.py`; `r4_kubo_ctp_apparatus_gate.py`; `trans_lambda_detector_response_leg.py`; `trans_lambda_finite_density_leg.py`; `r8_catalogue_nuisance_stack_gate.py`; and `r8_lensing_readout_deep_extension.py`.

B Tier vocabulary

settled Proven at the stated grade with no named premise outstanding; kill requires overturning the proof or its inputs.

derived Computed from the framework with no free choices; carries a named residual budget instead of a dial.

derived-conditional Derived modulo an explicitly named premise whose own proof is an open item.

registered A value placed on the table with trials accounted, before the deciding derivation or measurement; never silently moved.

null A quantitative anti-claim the framework imposes on itself; violation falsifies.

killed Executed by data or by derivation; retained in the ledger with date and mechanism.

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