Theory of the Intersection of Fields

Structured exposition

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A framework in which masses, charges and constants are not parameters but consequences of an interface geometry — set out by its logic, with the status of every claim stated plainly.

0. How to read this document

This document is an exposition, not a logbook: it is organised by the logic of the framework, not by the history of its construction. An internal research log, with its dead ends and its dated corrections, underpins every claim presented here, but is not needed to read it: everything required to understand and to check is contained in the present document. Nobody reads a document of this kind from end to end: the table of phenomena in Section 1 is your entry point — each line points to a self-contained section that can be read on its own.

Every claim carries one of four broad statuses, refined in the tables, and the honesty of these labels is the framework's method itself:

DERIVED — obtained from the principles of the framework by a reproducible calculation, with no tuning to the measured value. The reproducible derivations are given in the appendices, each with its check of units.

MEASURED–DECLARED — an experimental value used as an input, declared as such. The framework keeps their number to a minimum; its single dimensional anchor is the vacuum energy density.

UNDER SEAL — a conditional result, recorded with its explicit reservations, awaiting a derivation or a measurement.

DEBT — what is not derived, named and dated. The complete register of debts is Section 13.

No-borrowing rule: the framework forbids itself to import external formulae into its derivations — no length defined by an imported mass, no tuning to a target; its only building blocks are its own primitives and what follows from them. This rule can be checked in every calculation appendix.

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The mathematics is in this document, not deferred elsewhere. Formulae appear in the course of the text, set out on their own line, and every derived result is worked through in full in a calculation appendix (Appendices A to Q), with its check of units — so that the calculation can be redone without any external source. A glossary of symbols (Appendix R) defines every quantity and every notation of the framework — its name, its physical meaning, its units — so that the reader never has to guess a notation.

What this framework genuinely achieves

Before the tables, here is what really sets this framework apart: results that most theories POSIT, and that it DERIVES. Each is worked through in full in the appendix indicated.

Three anchors, of which two are measured directly. The whole framework rests on three anchors and on geometry: the vacuum energy density ρ_Λ (the cosmic anchor: gravity, the constants and the galactic threshold follow from it), the density of matter at the ceiling ρ_{nuc} (the anchor of matter, fixed from within by a single measured count, the saturation density), and the tension σ. The status of σ must be said plainly: it is an anchor of structure, but its numerical value is not measured independently — it is obtained from ρ_Λ and Newton's constant, $\sigma = \sqrt{(c^4\rho_\Lambda/12\pi G)}$. G is therefore an input wherever σ enters, and Table 1.3 says so line by line. The interval between the two bounds of scale carries the fine-structure constant, and their midpoint the electroweak energy. Where the Standard Model carries some twenty free parameters and MOND posits one, this framework has three, and they are properties of the fields — plus, sector by sector, one declared constant.

a_0 derived — rotation curves without dark matter. The acceleration scale of galaxies, which MOND puts in by hand, is here drawn from the anchor: $a_0 = (5/48)\cdot c^2\cdot k = 1.203\times10^{-10}$ m/s², within 0.3 % of the measurement. Nowhere else is a_0 derived. (Appendix F)

The mixing angle derived. $\sin^2\theta_W = 3/8$, the canonical unification value, is computed from the charge content of one generation — which the Standard Model measures. (Appendix C; what this calculation assumes is stated in S.6)

Three colours, three generations — counted, not postulated. $N_c = 3$ and $N_{gen} = 3$ come out of the structure, together with the rule “fractional ⟷ coloured”, which explains why quarks carry colour and leptons do not. (Appendix I)

The running of α without virtual particles. The slope 2/3π, which QED obtains from virtual pairs emerging from the vacuum, is here derived from the framework's own spectrum — a native route, with no virtual particles. (Appendix B)

The spin–statistics theorem, proved. That half-integer spin FORCES Fermi statistics — a postulate everywhere else — is here proved, by two independent topological routes that converge. (Appendix B)

10.5281/zenodo.22668459

Conservation of black-hole information. With no singularity (a finite curvature floor) and no horizon (the emergent space-time ends at the tension ceiling), the information paradox does not arise — three absences derived from a single fact.

Light derived. The photon is not posited: its composite nature, its two polarisations and its vanishing mass all follow from the geometry of the interface. (Appendix A)

None of these results is a fit: each is computed in its appendix, with its check, and the framework names honestly, alongside them, what it still owes.

1. The results in brief

1.1 The table of phenomena — your entry point

Every familiar object of physics, where the framework accounts for it, and its status in one word.

Phenomenon	What the framework says of it	Status	§
The photon	Light: the rotation of the internal frame of the three fields along the interface; its screening (the running of α) derived	Derived	7
The electron	A resonance driven by the nucleon; charge sign, spin ½ and statistics derived; its mass: target not reached	Derived / Debt	7, 9
The muon, the tau	The ladder of generations; the lepton masses: the Koide relation is derived under the dilation–winding identity (one turn of phase = one step of scale; the tau predicted from e and μ); the absolute scale is fixed by a measurement, as in any theory	Ratios derived (Koide, under the identity); scale measured	9
The neutrino	The neutrino is its own antiparticle (Majorana): with no charge to reverse, "anti" is merely the other chirality of the same object. Structural, with no new assumption — and falsifiable (neutrinoless double beta decay)	Derived / Prediction	9
The nucleon	Matter at saturation: the interface filled at the nuclear scale (all three fields engaged), confined and therefore extended (~1 fm, the colour that the confining potential grips), carrying the full inertial charge. The mass	Structure derived / 1836 bracketed	9

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	ratio 1836: bracketed, not derived		
Neutron stars	The same mechanism as the nucleon, at the astrophysical scale: saturated matter, filled to its tension ceiling. Nucleon and neutron star are the same object — the interface at its maximum — seen at two levels of the cascade; neither exotic nor singular	Derived (structure)	9
Quarks	Charges in thirds, the three colours AND the rule "fractional = coloured", all derived	Derived	8
Gluons	Not states, but transitions between fields (colour + anticolour). 3 × 3 = 9 passages minus the one that changes nothing = 8 gluons; their coupling — the three-gluon vertex — follows from the commutator of two transitions	Derived	8
The three forces	The three forces (electromagnetic, weak, strong) unified by a common rule: the same origin (the three structures of a frame), the same weight ½ at birth, the same law of variation (the count of sources present, S27, with the carrier at (11/3)·N_i) — predictions at the Z from the anchors: $1/\alpha$ −0.8 %, α_s +2 %, $\sin^2\theta_W$ −1 %; three meeting points of a birth in descent, not a single point	Derived	8
The strong force	The strong force grows with distance, the reverse of electromagnetism (asymptotic freedom, Nobel 2004): the self-interaction of the carrier (the 11) outweighs the screening of the content (the 4). The framework derives the sense and both numbers — $b_0 = 11 - 4 = 7$, the measured coefficient of chromodynamics.	Derived	8
The electromagnetic force	The phase (the singlet): the photon derived (two polarisations, vanishing mass), the constant α derived (0.3 %), the running	Derived	7, 8

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	derived (one share per charged winding present: 1/α at the Z to −0.8 % from below), charge as side membership		
The weak force	The sides (su(2) derived): the change of side of a winding; the angle 3/8 derived; the scale computed at the median plane (1.1 %, strong candidate); the slopes produced by S27; the proton–neutron interaction and beta decay, one and the same act; chirality a candidate	Derived (structure, angle) / Strong candidate (scale)	8
Confinement	Why a free quark or gluon is never observed: rigidity with no restoring term gives a linear potential E(r) = T_restoring·r, whose cost grows without bound — colour stays locked in. The form (linear) is derived; the field restoring force computed by a count of fields: 924 MeV/fm against 890–980 measured — strong candidate	Derived	8
The constant α	The fine-structure constant: α^{-1} = 137.44, from the tower and the angle of the generation circle; no measured input under the zero-point fluctuation conjecture — a fixed point (see S.5)	Fixed point under a conjecture — strong candidate (0.3 %)	7
Gravity, galaxies	Flat rotation curves, without dark matter: below a derived critical acceleration (a_0 = 1.20×10^{-10} m/s², within 0.3 % of the measurement), gravity departs from Newton and the velocity levels off. The mechanism (interference of presence intermittency, §3.7bis) reproduces galaxies; clusters remain in deficit	Candidate: galaxies derived, clusters in deficit	11
Wide binaries	The flagship prediction: a precise velocity excess in very widely separated double stars, two scenarios (0.323 / 0.305), which Gaia DR4 will settle in 2026	Dated prediction	12
The vacuum, ρ_Λ	The vacuum energy density (the cosmological constant): the single dimensional anchor of the framework,	Measured–declared	6

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	the zero-point of the interface cut off at its own scale		
Decoherence	Intrinsic decoherence vanishes below a derived saturation boundary in density ($\rho_{max} \approx 27$ g/cm³) — superpositions are preserved, whatever the material; beyond it, the object is classical. This is the same zero as standard quantum mechanics across the whole accessible range; the boundary ρ_{max}, the only distinguishing feature, is not directly testable	Derived (= standard QM wherever we measure)	10
Casimir, Lamb, g−2	The correspondence table between objects of the framework and measured effects; g = 2 native	Partial	7, 10
Degenerate matter	Beyond the saturation boundary: delocalisation of the centre of mass is excluded	Consequence	10
Inertia	The inertial charge: the mechanism by which an excitation resists motion — what plays the role of mass	Partial	9
The vanishing photon mass	The gauge direction is flat: the carrier cannot weigh	Derived	8
The Higgs mode	The native analogue of the Higgs field exists: the rigidity of the interface modulus — precisely its characteristic feature	Derived	8
Antimatter	Never primordial (theorem); the positron is the torsion of the other side	Derived	7, 11
The absence of baryogenesis	The interface settled in a single event fixing one orientation: this produced matter, not antimatter. No imbalance to explain — a distinctive prediction, at odds with the standard account	Prediction	11
Entanglement	Two entangled particles are the same wave, projected in several places through the deep geometry of the fields — not action at a distance; the support ($\mathbb{C}^3 \otimes \mathbb{C}^3$) is native	Native line of work	10
Gravitational lensing	Follows the dynamics by construction — wherever galactic dynamics is	Derived (structure)	11

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	anomalous, light is anomalous in the same way		
The Hubble constant	The framework's number falls between the two conflicting determinations (67.4 / 73.0); H_0 and a_0 proceed from a single quantity	Derived	11
Mercury	The precession recovered: 43.0 arcseconds per century (theorem)	Derived	11
Gravitational waves	Carried by the singlet, non-dispersive — as observation requires	Derived	11
The equivalence principle	Extended sector by sector: the identity geometry = gravity, by two converging chains	Derived	11
Black holes	No singularity, no horizon; information conserved (theorem). And a derived minimum mass: no black hole below 16.9 µm — $M\_min = 1.1\times10^{22}$ kg (5.7×10^{-9} $M\_\odot$) — hence no final evaporation, and the "asteroid" window for primordial black holes as dark matter is empty	Derived	11
Genesis	The Big Bang reread as the stabilisation of the intersection — a geometric reinterpretation, status declared; the bound of genesis	Reinterpretation	11
The nuclear radius (^{48}Ca)	The constant charge radius of the isotopes: the saturating response of the tension — the nuclear sibling of the quantum boundary	Derived	9
Light deflection	Derived in full, with no calibration (§3.12quinquies); the lock lifted: the metric governs motion, γ = 1 derived (§3.12sexies)	Derived	11
Electron shells (2, 8, 18, 32)	The filling numbers of chemistry — which standard physics observes without deriving them — are derived	Derived	9
Nuclear magic numbers	Reproduced by calculation, with an unexpected convergence with established nuclear physics; spin–orbit as curvature of the interface, of surface nature	Derived / Partial	9
Nuclear radii	R = a_nuc·A^(1/3): the	Derived (S25) / Anchor	9

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	exponent derived; the surface term at √3 derived from S25 (z predicted 0.402 fm; blind fit 0.36–0.43); a_nuc = the declared scale anchor, under theorem		
King plots	The non-linearity predicted where standard theory requires a strict straight line — the observed deviations are debated; a transverse test in the appendix	Prediction	12
The proton radius by probe	The charge radius is a property of the object, not of the probe: the extent of the doublet does not depend on the particle that explores it. The framework contains no mechanism that would make a muonic determination differ from an electronic one	Prediction — the two determinations have converged since 2019	9
Wave-function collapse	A detection is local: it bears on an excitation present across several fields (P5). What is called collapse is a limitation of the measurement, not a physical collapse	Derived	10
Time	Emergent and geometric: it does not exist at the fundamental level of the fields — an isolated field is its own structure, with no before or after; its arrow is fixed at the stabilisation of Σ, as a global labelling	Derived	6, 11
The vacuum energy divergence	The 120-orders problem: the zero-point is not summed to an arbitrary cut-off but cut at the proper scale of the medium, which gives the local identification $\rho_\Lambda = \sigma \cdot k$. The discrepancy with an uncut sum remains unresolved	Partial	6
Short-range gravity	A modification of the law below the cell scale (~30 µm) — a prediction with no free parameter, conditional, compared with the torsion-balance literature	Prediction (cond.)	11, 12
CMB anomalies (large angles)	The modal structure of the interface — three curvature contributions — compared with the anomalies at large angular scales	Partial	11
CMB uniformity without	The same temperature	Line of work	11

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inflation	everywhere, even between regions never in causal contact (the horizon problem): obtained as an effect of stabilisation over a large surface, without postulating inflation; coherent but not yet quantitative		
The zeta function and Riemann	The GUE statistics of the operator T against the distribution of the zeros of zeta (Montgomery–Odlyzko); the Berry–Keating conjecture examined	Correspondence	6
The neutron	A saturated, silent source: the internal balance of torsions (q = 0, verified below 10^{-21} e); positive core, negative periphery (S24); the magnitude $\langle r^2\rangle_n = -0.117$ fm^2 computed from the two presence bounds (one crossing): +0.5 %	Derived / Strong candidate	9
Unification without proton decay	The angle 3/8 derived with no quark↔lepton generator — the proton stays stable; the three forces do not meet at a point but two by two (10^{13}, 10^{14}, 10^{17} GeV): three separations of a birth in descent, each at the common weight ½ — order and spacing derived given the scale of the birth (10^{13}, read off the measured angle, not derived)	Derived (angle, stability) / Derived under the birth (meeting points)	8, 12
The weak energy	The change of side of a winding, paid at the median plane of the interface: $m_e \cdot e^{(L/2)}$ = 84.7 GeV = $\sqrt{(M_W \cdot M_Z)}$ to 1.1 %; W, Z, v, G_F follow from the derived angle	Strong candidate	8
The valley of stability	Not a force: the bare cores of the protons (a_c derived) against the cost of asymmetry (exclusion plus the p–n crossing at the median plane), weakened by the surface; N/Z of heavy nuclei to ±2.5 % with no parameter	Derived under the source statements S25–S26	9
The giant dipole resonance	Protons against neutrons in opposition — the change of side balanced in pairs; its restoring energy reads a_{sym} ≈ 19–21 MeV, above	Identified	8, 9

10.5281/zenodo.22668459

	exclusion (14)		
The chirality of the weak force	The screw derived (rotation × advance towards the vacuum): one hand per side, the opposite for antimatter, CP preserved at the level of a single screw; the violation lives in the mixing of the three residences (see S.12: the violation lives in the mixing of the three residences) — under the assumption that the winding realises the cyclic order of triality (flagged by the framework); residue: one bit of orientation fixed at stabilisation, not derived	Strong candidate (under an assumption)	8
The Planck scale	Two routes of the framework to Planck coincide: gravity (the framework's Planck mass, $\sigma \cdot \sqrt{\hbar/c^3\rho\_\Lambda} = 1.99\times10^{18}$ GeV, from the tension and the vacuum anchor) and the birth of the interface (S28: twelve half-turns of π above the median plane, from m_e, the tower and the twelve rotations: 2.04×10^{18}) — within 3 %; the framework's Planck mass equals $\sqrt{\hbar c/12\pi G}$ numerically, so G is the input of that route — what is tested is e^(−12π − L/2) = m_e/M_F; read backwards, the electron mass comes out of the anchors	Prediction (S28)	8, 11
The electron mass	From the three anchors and the count of rotations: from the framework's Planck mass ($\sigma \cdot \sqrt{\hbar/c^3\rho\_\Lambda}$) one descends twelve half-turns to the median plane (S28), then half the height of the tower of anchors (L/2 e-folds) to the limit object — m_e = 0.509 MeV against 0.511 measured (−0.4 % under the harmonised cell). The declared constant of the lepton sector is no longer free, and the nucleon–electron wall is bypassed from above	Consequence of the anchors — strong candidate	8.6, S
The vacuum share (Ω_Λ), flatness, age and expansion	The prediction is Ω_Λ = 2/3 exactly ($H_0^2 = 4\pi G\rho\_\Lambda/c^2$) —	Derived prediction: Ω_Λ = 2/3 (measured 0.6847 ±	3, 12

10.5281/zenodo.22668459

	the agreement between the tension read off gravity and off the expansion; H_0 (68.6, measured 67.4–73), the proper time (14.3 Gyr) and the perceived age with dilution (13.3 Gyr, measured 13.8) follow as in any cosmology, through Friedmann; the universe is flat: $\Omega_\Lambda + \Omega_m = 1$ under phase equipartition of the three modes (mass on the singlet), consistent with the vanishing mean curvature of the stable interface (Ω_k measured 0.000 ± 0.002); relation (not derived — see S.13, §3.12): $H = \sqrt{3}\cdot c/R_\Sigma$	0.0073, offset 2.7 %, 2.5σ — tension named)	
The nucleon mass	Three residences, each at the energy of the locus where tension and rigidity cross over ($\ell_c = a/\sqrt{3}$): $E_N = 3\sqrt{3}\cdot\hbar c/a$ = 964 MeV (measured 939, +2.7 %); from the saturation density alone, with no mass: 964 MeV — the nucleon–electron wall opened from above	Strong candidate (2–3 %, the precision of the anchor)	8
The neutron skin	In a nucleus, the density radius exceeds the charge radius in proportion to the neutron excess $(N - Z)/A$, and the difference vanishes exactly at $N = Z$ — a direct consequence of the two modes (charge on the doublet, density on the singlet), with no parameter	Verified on six nuclei (r = 0.914) — strong candidate	9

1.2 The numbers — derived against measured

The framework's showcase: what it computes from its geometry, set against what experiment reports.

Quantity	The framework (derived)	The measurement
Inverse fine-structure constant	$2\pi(L-2)(1-d^2) = 137.44$	137.036 (offset 0.3 %)
Slope of the leptonic running of α^{-1}	0.21218 per e-fold	$2/(3\pi) = 0.21221$ (structurally exact)
Sense of the running of the strong force	Antiscreening (sign derived)	Asymptotic freedom (Nobel 2004)
The coefficient of the strong force	$b_0 = 11 - 4 = 7$ (the eleven of the carrier, the four of the content)	$b_0 = 7$ (QCD, full content)
Mixing angle at the native scale	$\sin^2\theta_W = 3/8$	3/8 at unification (GUT schemes)
The spectrum of electric charges	0, ±1/3, ±2/3, ±1 — and nothing else	Identical
Colours; generations	$N_c = 3$; $N_{gen} = 3$ (derived, with the selection rule)	3; 3

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Magnetic moment of the electron	g = 2 native (holonomy of the half-turn)	g = 2.0023 (the offset = the running)
The spin–statistics connection	Theorem (two independent routes)	A postulate, verified everywhere
Quantum–classical boundary	$\rho_{max} = \sqrt{3}\sigma/(ac^2) = 27.0$ g/cm³	No other theory puts a number on one
Wide-binary offset (Gaia DR4)	Fork: 0.323 (A) / 0.305 (B)	Verdict: late 2026
Galactic acceleration threshold a_0	$(5/48)\cdot c^2k = 1.203\times10^{-10}$ m/s²	≈ 1.2×10^{-10} (empirical, rotation curves)
Galactic rotation law	$g_{obs}/g_N = 1 + 0.323/\sqrt{x}$ below threshold	Flat curves; Gaia DR4 judges (2026)
PPN parameter γ (light bending)	γ = 1, derived — the metric governs motion	Cassini: $\gamma - 1 = (2.1 \pm 2.3)\times10^{-5}$
PPN parameter β	β = 1 exactly ($g_{00} = -e^{(2\Phi/c^2)}$)	Consistent with every bound
Solar deflection of light	Derived in full, with no calibration	1.751 arcseconds (Eddington and successors)
Precession of Mercury	43.0 arcseconds per century	43.0 (measured)
Hubble constant and age of the universe	$H_0 = k\cdot c_a = \sqrt{3}\cdot c/R_\Sigma = 68.6$ km·s⁻¹·Mpc⁻¹; the proper time $T_\Sigma = 1/H_0 = 14.3$ Gyr; the perceived age with dilution $t_0 = 13.3$ Gyr — from σ and ρ_Λ, with no H_0 as input	67.4 (microwave background) / 73.0 (distance ladder); age 13.8 Gyr (−3 %) — derived (§3.12, no adjusted parameter); the supernova diagram reproduced to ≤ 0.07 mag
Electron shells	2, 8, 18, 32 — derived (standard physics observes them without deriving them)	The periodic table
Nuclear magic numbers	Reproduced; spin–orbit as surface curvature	2, 8, 20, 28, 50, 82, 126
The lepton mass sector	Ratio = 8/15 × (1 − d²), with d = 4.9° measured (form derived)	The Koide criterion (Q = 2/3 to 10^{-5}) is the judge of the sector
Law of nuclear radii	$R = a_{nuc}\cdot A^{(1/3)}$ — the exponent derived; the √3 edge (S25)	Measured charge radii: z fitted 0.36–0.43 against 0.402 predicted
Charge radius of the proton	From the energy, with the electron subtracted: −2.8 %; with the two bounds (two crossings, 1/12): −0.1 %	0.841 fm measured; independent judge: the neutron
Minimum mass of a black hole	$M_{min} = a_{min}\cdot c^2/2G = 1.1\times10^{22}$ kg (R = 16.9 µm)	No evaporation burst detected (Fermi, HAWC); the PBH window 10^{17}–10^{23} g is excluded
Squared charge radius of the neutron	Sign (S24) and magnitude: −0.117 fm² (one crossing, 1/8)	−0.116 fm² measured (+0.5 %); swapping the exponents fails by 18 %
Weak scale (median plane)	$m_e\cdot e^{(L/2)} = 84.7$ GeV	$\sqrt{M_W\cdot M_Z} = 85.61$ GeV (−1.1 %)
W and Z masses	$M_W = 79.6$ GeV; $M_Z = 90.3$ GeV (through the derived angle)	80.37; 91.19 measured (−1.0 %)
Fermi constant	$G_F = \sqrt{2}\cdot g^2/(8M_W^2) = 1.185\times10^{-5}$ GeV⁻²	1.1664×10^{-5} measured (+1.6 %)
Cost of the bare cores (valley)	$a_c = (3/5)\cdot\alpha\cdot\hbar c/r_0 = 0.72$ MeV (r_0 = 1.20 fm, the equivalent uniform sphere — a charge radius, R_q)	0.71 MeV (semi-empirical formula)
Volume asymmetry cost S_0	exclusion 11.1 + crossing 20.8 = 31.9 MeV (at r_0 = 1.20)	31.6 ± 2.2 MeV measured (+1 %)
Valley of stability, lead-208	N/Z = 1.51 (r_0 = 1.20, with no compensation); U-238: 1.55	1.537 measured (−1.8 %); U: 1.587 (−2.3 %)
Field restoring force (confinement)	$T = 3\sqrt{3}\cdot E_N^2/(8\pi\hbar c) = 924$ MeV/fm; $\sqrt{\sigma}$ = 427 MeV	$\sqrt{\sigma}$ = 420–440 MeV (Regge); one combination out of twelve — strong candidate
Strong coupling at the Z, $\alpha_s(M_Z)$	0.120 — the bare plateau (g² = 1) at the confinement locus (a/√3, 319 MeV), brought down with the constant slope per e-fold and the count of windings present (S27); above 2 GeV	0.118 measured (+2 %, the offset between conventions — the running is a closed law); strong candidate; near the floor, established under the presence mechanism: the force

10.5281/zenodo.22668459

	the measurement is tracked to ~3 %	between two colours sees the coupling times the presence of the displaced colour (¼ at the edge of the cell)
Force between two colours, 0.1–1 fm	$F(r) = T + (4/3)\cdot\alpha(\hbar c/r)\cdot f(r)\cdot\hbar c/r^2$ — the restoring force of the three fields, plus the response of the medium to a probe weighted by the presence of the displaced colour, $f(r) = (½)^{(2r/\ell_c)}$; no parameter	Lattice: $F = \sigma + e\cdot\hbar c/r^2$, $e \approx 0.29$; the presence factor reproduces the coefficient from 0.05 to 0.62 fm to 7 % — P5 under the identity turn = step = length, with no parameter; the form is not exclusive within the ± 9 % margin of the target
1/α at the Z, from below	$1/\alpha(M_Z) = 126.97$ — from 137.44 below, rising with the count of charged windings present (S27)	127.95 measured (−0.8 %); the same rule as the strong force, judged for the phase
Mixing angle at the Z (not a prediction: the birth scale μ_{12} is read off this angle)	$\sin^2\theta_W(M_Z) = 0.229$ — from 3/8 at birth (10^{13} GeV) with the slopes produced by S27 (⅓ per doublet present; the phase charges through the sides and Q; the native Higgs a singlet)	0.2312 measured (−1.0 %); the two other meeting points predicted: 2.2×10^{14} and 7.2×10^{16} GeV; the carrier of the sides, (11/3) per unit times two sides — derived
The bound of the birth (Planck)	$E_{median} \cdot e^{(12\pi)} = 2.04\times10^{18}$ GeV — the twelve rotations of the frame above the centre	The framework's Planck mass, $\sigma\cdot\sqrt{(\hbar/c^3\rho_\Lambda)} = 1.988\times10^{18}$ GeV (+2.6 %); Planck is not targeted; G enters through $M_F = \sqrt{(\hbar c/12\pi G)}$ — what is tested is the ratio $e^{(-12\pi - L/2)}$
The electron mass from the anchors	$m_e = \sigma\cdot\sqrt{(\hbar/(c^3\rho_\Lambda))} \cdot e^{(-L/2 - 12\pi)} = 0.509$ MeV — from the tension, the vacuum anchor, the tower L and the twelve rotations (S28)	0.511 MeV measured (−0.4 % under the harmonised cell); a consequence of three properties of the fields — strong candidate
The vacuum share of the universe	$\Omega_\Lambda = 2/3 = 0.667$ — the 4π of $H_0^2 = 4\pi G\rho_\Lambda/c^2$ (12π/3, derived); and the equipartition of the three modes: mass on the singlet (1/3), vacuum on the doublet (2/3)	0.6847 ± 0.0073 measured (Planck 2018); offset 2.7 %, 2.5σ — prediction, tension named; the phase equipartition is that of S14, exact
The size of the interface	$R_\Sigma = 3\sigma/\rho_\Lambda = 2.3\times10^{26}$ m = 24.7 billion light-years = 1.73 Hubble radii	With no observational counterpart (between the Hubble horizon, 1.4×10^{26}, and the observable, 4.4×10^{26}); projection onto the large angles of the microwave background is excluded by the framework — R_Σ is a relation, not derived (see S.13)
The matter in the closure volume	$\rho_m = \rho_\Lambda/2 = 2.95\times10^{-27}$ kg/m³; $M_\Sigma = 1.6\times10^{53}$ kg ≈ 10^{80} nucleons; $\rho_c = 3\rho_\Lambda/2 = 8.9\times10^{-27}$ kg/m³	The Eddington number (~10^{80}); ρ_c measured 8.5×10^{-27} (+4 %) — consequences of the 1/3 share
The temperature of the microwave background	$T_{CMB} = (\rho_\Lambda/a_{rad})^{1/4} \cdot e^{(-3\pi/4)} = 2.742$ K — the vacuum lowered by one half-turn of density per field	2.7255 K measured (+0.6 %, within the margin of ρ_Λ) — candidate mechanism, a new relation
The matter share and the curvature	$\Omega_m = 1/3$ (mass on the singlet, T3; the phase equipartition of the three modes, S14); $\Omega_\Lambda + \Omega_m = 1 \Rightarrow \Omega_k = 0$: the universe is flat — consistent with the vanishing mean curvature of the stable interface	$\Omega_m = 0.315 \pm 0.007$ (+5.8 %); $\Omega_k = 0.000 \pm 0.002$ — flatness judged exact; a coherent reading (T3, T16, S14), not a theorem — see S.13
Muon-to-electron mass ratio	$m_\mu/m_e = (\pi/8)\cdot e^{(2\pi)} = 210.3$ — the leptonic saddle of depth R = 2π, one turn of the winding = 2π e-folds (the same conversion as S28 and the microwave background)	206.77 measured (+1.7 %); R* = 6.266 against 2π = 6.283 (0.27 %) — the dilation–winding identity, a source statement, judged

10.5281/zenodo.22668459

The nucleon mass	$E_N = 3\cdot\hbar c/\ell_c = 3\sqrt{3}\cdot\hbar c/a_{nuc} = 964$ MeV; $m_N = (3\sqrt{3})^{(4/3)}\cdot\hbar c\cdot n_0^{(1/3)} =$ 964 MeV ($n_0 = 0.16\ \text{fm}^{-3}$, with no mass as input)	938.9 (proton), 939.6 (neutron) measured — +2.7 %; strong candidate; the ratio 1836 becomes the ratio of two masses held by the anchors
Pairing coefficient (light nuclei)	$W = 3\cdot E_{cross} = 62.4$ MeV — a nucleon without a partner unbalances all three fields at once (three residences, S26); term $W\cdot\lvert N - Z\rvert/A$	Free fit in continuous Z: 61–64 MeV (2.9–3.1 × E_{cross}); the standard Wigner value 47; Fe-56: 1.18 against 1.154 — strong candidate
The Hubble diagram (supernovae)	$H(z)^2 = H_0^2\cdot[(1/3)(1+z)^3 + 2/3]$ — dilution by cells, the derived shares, $H_0 = k\cdot c_a$; $z_t = 0.59$	μ(z) reproduced from z = 0.1 to 2 to 0.04–0.07 mag (ΛCDM: 0.02); z_t measured 0.63; de Sitter (+1.1 mag at z = 2) and matter-only excluded — derived, with no history
Primordial helium	$Y_p = 2\cdot f_n\cdot(1 - f_e\cdot f_\mu^2) = 63/256 = 0.2461$ — $f_n = 1/8$ the presence of the neutron's internal compensation; 1/64 one attempt at a complete change of side; with no duration	0.2458 ± 0.0013 measured (2026): +0.2σ; resummation excluded (−13σ); standard BBN 0.2467 — strong candidate, one judge
The neutron skin	Density radius (singlet, all nucleons) − charge radius (doublet, protons only) ∝ (N − Z)/A, vanishing at N = Z — with no parameter	Six nuclei: correlation 0.914; slope 0.915 ± 0.076 fm; Ca-40 (N = Z): −0.01 ± 0.03 — sign, law and zero delivered; slope not computed

1.3 What goes in — the measured inputs, result by result

The framework posits three anchors — the tension σ, the vacuum density ρ_Λ, the density of matter at the ceiling ρ_{nuc} — and derives the rest. This table states, for each result of Table 1.2, which measured values actually enter the calculation, and which do not.

Three points hold for the whole table.

(i) σ is an anchor of structure: its numerical value is at present read off gravity, $\sigma = \sqrt{c^4\rho_\Lambda/12\pi G}$, since the closure radius $R_\Sigma = 3\sigma/\rho_\Lambda$ has no named observational counterpart; any result that passes through σ therefore passes through G.

(ii) ρ_Λ is itself obtained from observed cosmology, $\Omega_\Lambda\cdot 3H_0^2c^2/(8\pi G)$: H_0 is in the input of everything that passes through ρ_Λ.

(iii) $a_{nuc} = 1.0635$ fm is fixed from within, by requiring the cascade and the content to agree at nuclear density; its only input is $n_0 = 0.16$ nucleons/fm³, a count per volume, with no mass.

A result is interesting only through what separates it from its inputs: the right-hand column says so.

Result	Measured inputs	Does not enter	Offset from measurement
Muon-to-electron mass ratio	None	m_μ, m_e	+1.7 % (R* = 6.266 against 2π: 0.27 %)
Fine-structure constant (below)	d = 4.9° (the angle of the generation circle); L (hence ρ_Λ, a_{nuc})	α	+0.3 %
Mixing angle at birth	None	$\sin^2\theta_W$	3/8 exactly (the value at birth)
Mixing angle at the Z	$\mu_{12} \approx 10^{13}$ GeV, read off this angle	—	not a prediction: the scale is read off the observable

10.5281/zenodo.22668459

Strong coupling at the Z	a_nuc (the locus ℓ_c = a/√3)	α_s, Λ_QCD	+2 % (convention offset, a reading)
Electroweak scale (median plane)	m_e; L (hence ρ_Λ, a_nuc); the angle and α at the Z for the split into W and Z	M_W, M_Z	−1.1 %
Electron mass	σ (hence G); ρ_Λ (hence H_0); a_nuc	m_e, the Planck mass	−0.4 %
Nucleon mass	a_nuc (or, with no mass, the saturation density n_0)	m_p, m_n	+2.7 %
Charge radii of the proton and the neutron	E_N = 938.9 MeV measured; a_nuc	The radii	−0.1 % and +0.5 %; with E_N derived (964): −7.6 % and +23.5 %
Valley of stability, nuclear radii	a_nuc; r_0 = 1.20 fm (a charge radius, R_q)	Nuclear masses	~1 % on N/Z (heavy nuclei)
Primordial helium	None	Y_p, the neutron lifetime, the baryon density	+0.2σ
Temperature of the microwave background	ρ_Λ (hence H_0)	T_CMB	+0.6 %
Hubble constant, age	σ (hence G); ρ_Λ (hence H_0)	—	H_0 +1.8 %; age −3 % — the content of the input limits what these lines test
Vacuum and matter shares	None, once the shares are defined as fractions of the modes	Ω_Λ, Ω_m	Ω_Λ = 2/3 exactly in the framework; measured 0.6847 ± 0.0073 (2.5σ)
Hubble diagram (supernovae)	H_0 (through ρ_Λ)	The luminosity distances	≤ 0.07 mag from z = 0.1 to 2
Galactic threshold a_0	σ, ρ_Λ	a_0, the rotation curve	$a_0/(cH_0)$ fixed by the same curvature k — see the coefficients 5/48 and 0.323 in the framework document
Neutron skin	None (once the two modes are distinguished)	The measured skin thicknesses	Sign, law and zero at N = Z delivered; slope not computed

Reading the table. Three lines test nothing beyond their own input and are kept for coherence, not as predictions: the angle at the Z, the Hubble constant and the age. Two carry a real offset, not covered by the uncertainty on the anchors: the electron mass and the vacuum share (2.5σ). The lines with no measured input at all — the muon-to-electron ratio, the angle at birth, primordial helium, the neutron skin — are the ones where the framework takes the greatest risk.

2. Foundations

2.1 The picture

Three fields fill the whole — three geometric manifolds, interchangeable as regards their tension: none is privileged, and this exact equivalence will carry immense consequences (the strong force will follow from it). Where the three meet there lives an interface, Σ — and this interface is our universe: everything we observe, matter, light, forces, is an excitation of Σ. But Σ is not the deep reality: it is the sum of the three fields, our point of view on them — everything

10.5281/zenodo.22668459

happens in the fields, and everything is read on the interface. A particle is not an object placed on this backdrop: it IS a configuration of the fields, including their zero-point fluctuations. This seemingly innocuous sentence will by itself decide the boundary between the quantum and the classical (Section 10).

2.2 The five postulates

The whole framework posits exactly the following, and nothing else:

P1 — The Whole. The totality, with neither metric nor topology; it contains without measuring. (The framework presupposes neither space nor time: they will emerge.)

P2 — The Fields. Three orientable Riemannian manifolds (M_i, g_i), each carrying its intrinsic geometry and duality; three fields plus the interface give four binary structures. (From these dualities the sides will arise — and from them, the sign of charges and antimatter.)

P3 — The Intersections. An intersection is stable if and only if the spectrum of its second variation is positive. (The criterion of existence: what lives is what holds.)

P4 — Surface Tension. At the interface there emerges the Hermitian operator T, with a real discrete spectrum of GUE statistics; $\langle T \rangle = 0$ at rest, $\langle T^2 \rangle \neq 0$; T redistributes without creating. (The single fundamental quantity of the framework — and its $\langle T^2 \rangle \neq 0$ is the zero-point: the vacuum fluctuates by a postulate of structure, not by addition.)

P5 — Observability. An excitation is a continuous wave in the fields, observable only at the intersections; no collapse — a detection is local. (The framework stands on the side of “the wave is everything”; Section 10 draws decoherence from it.)

P6 — Time. Time is not primitive; it emerges as the direction of redistribution of T. (Proved from P1–P5 with the Lorentzian signature — a postulate turned theorem.)

P7 — Dimensional Selection. The 3+1 structure is forced. (Proved by four internal arguments — a postulate turned theorem; see T4.)

P8 — The Arithmetic Correspondence. A PROGRAMME, not an achievement: the link between the GUE statistics of T and the zeros of the zeta function — the Berry–Keating identification is declared obstructed by the framework itself.

Fine structure: P2 unfolds into P2a–P2c (the intrinsic geometry of a field; duality; the derivation of spin from the two normals) and P4 into P4a–P4e (the properties of the operator T). The framework's live numbering therefore runs from P1 to P8: five founding postulates, two postulates turned theorems, one programme.

From these five postulates, by the stability criterion and geometry alone, there follow: a cell scale, an equation of motion, a spectrum of charges, an algebra of forces, and the theorems of Section 4. The rest of this document unrolls that chain.

2.3 The modes: the singlet and the doublet

10.5281/zenodo.22668459

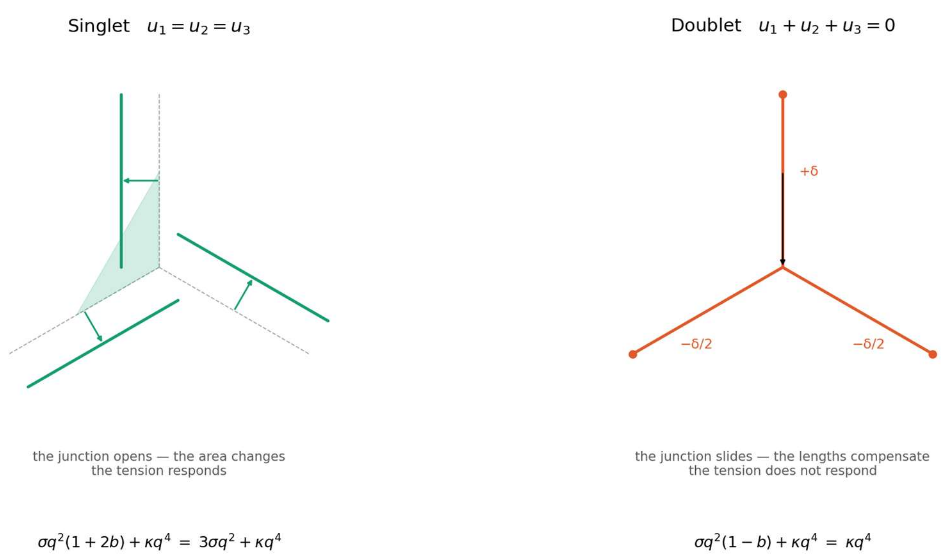
An excitation of the interface distributes itself over the three fields — but not in any manner whatever. Because the three fields are interchangeable (none is privileged), their displacements separate naturally into two families:

The singlet — the share common to all three fields, what they do together, in unison: a stiff mode. It carries mass, acoustics and gravity, and it carries the heavy generation.

The doublet — the two relative shares, the phase differences between the fields: two soft modes. It carries light and the soft electroweak sector.

This is the decomposition 3 = 1 ⊕ 2. It is not posited: it follows from the exact equality of the three fields. And it organises the whole physics of the framework — on one side what weighs and attracts, on the other what radiates:

3 = 1 ⊕ 2 (one stiff singlet + one soft doublet)



The two modes of the common wall, as a diagram of amplitudes. The three branches at 120° represent the normal displacements u_1, u_2, u_3 of the three fields that share Σ: a diagram of modes, not the geometry of Σ. Σ is a common wall of codimension 1 — a single normal, hence two sides (P6, S21) — and not a triple junction of codimension 2; the image of the triple junction (domain walls) is an analogy, flagged as such.

The displacements u_i are measured along the common normal. The singlet ($u_1 = u_2 = u_3$) opens the junction: the area changes, the tension responds — a stiff mode, $3\sigma q^2 + \kappa q^4$. The doublet ($u_1 + u_2 + u_3 = 0$) makes it slide: the lengths compensate, the tension does not respond — soft modes, κq^4. It is this difference that makes a mass — which calls on the tension — live only on the singlet (T3).

10.5281/zenodo.22668459

3. The laws

Space, time and gravity emerge from three properties of the fields. The framework has only three anchors, and all are properties of the fields: the tension σ, the vacuum density ρ_Λ, the density of matter at the ceiling ρ_{nuc}. Nothing spatial, temporal or gravitational is given. Space emerges as the closure of the interface ($R_\Sigma = 3\sigma/\rho_\Lambda$); time, as the path of light over the length that governs the expansion ($T_\Sigma = R_\Sigma/(\sqrt{3}\cdot c)$ = 14.3 Gyr, the proper time of the interface; the age perceived from within, with dilution, 13.3 Gyr — measured 13.8); gravity, as $G = c^4\rho_\Lambda/(12\pi\sigma^2)$; the expansion, as H_0 = 68.6 km/s/Mpc (measured 67.4–73).

The light of the interface. Each field alone carries its waves at c. The interface is three fields at once: a wave running in Σ must drag all three together — three times the inertia for the same tension, and a wave travels as the square root of the ratio of tension to inertia: √3 times slower. The proper speed of the interface is $c_a = c/\sqrt{3}$, about 58 % of c — a long-standing number in the framework, and in no way a tuning.

The age of the universe. The interface of the three fields closes where its tension balances the pressure of the vacuum, at the radius $R_\Sigma = 3\sigma/\rho_\Lambda$. Time is not a backdrop: it is the direction normal to Σ, and a duration is counted as a path — the path travelled by the light of the interface. The age of the universe is the time light takes to traverse the length that governs the expansion, $R_\Sigma/\sqrt{3}$ — the whole interface engages the three fields, and its stiffness is 3σ:

$$T_\Sigma = R_\Sigma/(\sqrt{3}\cdot c) = 1/H_0 = 14.3\ \text{Gyr (the proper time)} \quad ; \quad t_0 = 13.3\ \text{Gyr (the perceived age, with dilution; measured 13.8)} \quad ; \quad H_0 = k\cdot c_a = 68.6\ \text{km}\cdot\text{s}^{-1}\cdot\text{Mpc}^{-1}$$

This is the derivation of §3.12: $H = c\cdot k/\sqrt{3}$, the √3 coming from the constraint $\langle T\rangle = 0$ (b = 1) — the same non-adjustable factor that fixes the short gravitational range. Nothing measured about the expansion enters this calculation: only the tension and the vacuum density.

The vacuum makes up two thirds of the universe. The same tension σ makes gravity ($G = c^4\rho_\Lambda/(12\pi\sigma^2)$) and the age ($T = R_\Sigma/(\sqrt{3}c)$). If σ is a single field constant, the two calculations must agree — and they agree to 2 %. Written as a relation between measured numbers, this agreement says that the vacuum occupies a fixed share of the universe:

$$H_0^2 = 4\pi G\rho_\Lambda/c^2 \quad \Leftrightarrow \quad \Omega_\Lambda = 2/3 = 0.667 \quad \text{(measured 0.6847)}$$

Why two thirds: the interface has three modes of equal weight — the singlet, which carries mass (T3), and the doublet, two relative modes; by phase equipartition (S14), the singlet carries one third of the density (matter) and the doublet two thirds (the vacuum). If the universe is the closed interface of three fields, its composition is not arbitrary. In full transparency: the age and H_0 are not independent predictions — they are the Friedmann equation with Ω_Λ fixed; the framework's prediction, the only one, is $\Omega_\Lambda = 2/3$ (Section 12, prediction 9).

The universe is flat — the stabilisation of Σ. The stability of the interface is, in the framework, a theorem: an intersection is stable if and only if it is a minimal manifold — its mean curvature

10.5281/zenodo.22668459

vanishes everywhere (Simons). Flatness is here attached to the stability of Σ, independently of its content — a coherent reading, not a theorem: the link between the mean curvature of Σ and the curvature of the emergent spatial slice is not written, and Σ, which closes at R_Σ, is not minimal in the strict sense — and the distribution of the modes gives its cosmological reading: $\Omega_\Lambda + \Omega_m = 1$ requires that no fourth contribution exist.

$$\mathbf{\Omega_\Lambda + \Omega_m = 2/3 + 1/3 = 1 \quad \Rightarrow \quad \Omega_k = 0 \quad (measured: 0.000 \pm 0.002)}$$

One might have expected a slight curvature from the mere fact that the universe is not empty; there is none, because the contributions that fill it are precisely those that cancel its mean curvature. The closure radius R_Σ is not a radius of curvature: it is the extent at which the interface closes. Where standard cosmology explains flatness by a phase of inflation, the framework obtains it by counting: three fields, three contributions, one sum.

The distant universe without a history — dilution by cells. The cell a is constant; what grows is the number of cells between two points. To look far is to see the interface where there were fewer cells between things: the same matter, fewer cells — denser as $(1 + z)^3$; the same radiation, fewer cells to stretch it — hotter as $(1 + z)$; the vacuum, being an anchor, does not dilute. The expansion rate was therefore larger far away, matter weighing more there. With the derived shares and $H_0 = k \cdot c_a$:

$$\mathbf{H(z)^2 = H_0^2 \cdot [(1/3)(1 + z)^3 + 2/3] \quad ; \quad z_{transition} = (2\Omega_\Lambda/\Omega_m)^{(1/3)} - 1 = 0.59 \quad (measured\ 0.63)}$$

The judge is the supernova Hubble diagram, from $z = 0.1$ to 2: the framework reproduces it to within 0.04–0.07 magnitude (of which 0.04 is the offset between 68.6 and 67.4 km/s/Mpc — the Hubble tension, not a defect of shape), with deceleration far away and acceleration near. Two controls: with no dilution (constant rate), the curve misses by +0.5 mag at $z = 1$ and +1.1 at $z = 2$ — excluded; with matter only, by −0.3 to −0.8 — excluded. It is the derived mixture, one third and two thirds, plus dilution, that reproduces the measurement, with no knob.

The composition of stabilisation — primordial helium, with no duration. Every turn that rises in energy settles into a winding and its compensation: a proton and an electron. The compensation is either projected (the proton, with the electron far away) or retained (the neutron: the same proton with its electron inside). The share of nucleons born as neutrons is the presence of the internal compensation, $f_n = f_e/(1 - f_\mu) = 1/8$ — the very object that gives the charge radius of the neutron. A neutron persists only when held by a crossing partner (S26); at stabilisation there are seven protons for each one, and a partner is always within reach: at the first attempt, either the partner completes the crossing — the pair, which ends up in helium-4 — or the neutron has flipped alone, with the weight of a single attempt at a complete change of side, $f_e \cdot f_\mu^2 = 1/64$.

$$\mathbf{Y_p = 2 \cdot f_n \cdot (1 - f_e \cdot f_\mu^2) = 2 \cdot (1/8) \cdot (1 - 1/64) = 63/256 = 0.2461 \quad (measured\ 0.2458 \pm 0.0013;\ +0.2\sigma)}$$

10.5281/zenodo.22668459

Three presences the framework already had — 1/16, ½ and the resummation of S26 — judged elsewhere; no duration, no parameter. And the ½ itself is derived: a side is one sense of the normal direction, leaving through it is a half-turn, and the projection onto the interface of a uniform phase rotation gives exactly one half. Beneath this chain no posited number remains: it descends to the phase itself. Controls: if the neutron resummed as the proton does (1/12), Y_p = 0.229 (−13σ); with no loss, 0.250 (+3σ). Standard nucleosynthesis, with its kinetics and the neutron lifetime, gives 0.2467. Status: strong candidate mechanism — two named readings, one judge, Y_p.

The temperature of the microwave background. The microwave background is the radiation emitted by the transient regime of stabilisation of the interface. Its temperature is not deduced, in standard cosmology, either from the expansion or from the age: it is an independent parameter, with no known relation to the vacuum density. The framework offers one: the vacuum density expressed as radiation ($\rho_\Lambda = a_{rad} \cdot T_\Lambda^4$) gives T_Λ = 28.9 K; the ratio ρ_Λ/ρ_γ is $e^{9.449}$, and 3π = 9.425 — three half-turns of π in density, one per field.

$$T_{CMB} = T_\Lambda \cdot e^{-3\pi/4} = 28.93\ \text{K} \times e^{-2.356} = 2.742\ \text{K} \quad \text{(measured 2.7255 K; +0.6 \%)}$$

Controls: two half-turns would give 6.0 K, four 1.25 K — three stands alone. Status: candidate mechanism, one native number, zero parameters, judged to 0.6 %; what would kill it: a value of ρ_Λ outside 5.3×10^{-10} ± 2 %, or a derivation of the count giving anything other than three.

The relations of the framework between its quantities — each with its status, its check of units in the appendix, and its section of development.

3.1 The field equation — and superposition for free

$(3\sigma/c^2)\cdot\partial_t^2 u - 3\sigma\nabla^2 u + \kappa\nabla^4 u = -\rho_E$ — the displacement u of the interface responds to the local energy density (a pressure: $J/m^3 = N/m^2$), with the tension σ of the three fields and a curvature rigidity κ. Exact static form: $\sigma\cdot Tr(K) = \rho_E$. The equation is LINEAR in u: any combination of solutions is a solution — the superposition principle is not an added quantum postulate, it is a mechanical property of the medium. [Derived from P2–P4; Appendix A.]

3.2 The saturating response

$T = k_F\cdot\delta\langle r^2\rangle/(1 + \beta\cdot\delta\langle r^2\rangle)$ — the response of the interface to a growing density saturates. This is the only non-linearity in the framework, and it carries two boundaries: the constant charge radius of the calcium isotopes (^{48}Ca, Section 9) and the quantum–classical limit (Section 10). [Form derived, calibration declared; Appendix A.]

3.3 The cascade — the scale that adapts

10.5281/zenodo.22668459

$a(\rho_E) = (\hbar c/\rho_E)^{1/4}$ — the cell of the medium tightens where energy concentrates. At rest (vacuum), the cell is $a = \sqrt{\kappa/\sigma} = 29.2$ µm; this is the resolution scale of the medium: nothing is distinguished below it, everything averages there. [Derived; Appendix A.]

3.4 The vacuum anchor

$\rho_\Lambda = \sigma \cdot k$ — the vacuum energy density IS the zero-point of the interface cut off at its proper scale. This is the framework's single dimensional anchor: one measurement (ρ_Λ) fixes σ, and everything else follows. The zero-point per mode: $\langle v_q^2 \rangle = \hbar/(2\rho_i c q)$, with $\rho_i = 3\sigma/c^2$. [Identification declared, unique; Section 6.]

3.5 The derived scales

From σ and a there follow, with no new parameter: the gravitational range $R_\Sigma = 3\sigma/\rho_\Lambda$; the maximum tension $T_{max} = \sigma/R_{min}$; the saturation boundary $\rho_{max} = \sqrt{3}\cdot\sigma/(a\cdot c^2) = 27.0$ g/cm³; the saturation variable $\varepsilon = \rho_E \cdot a/(\sigma\sqrt{3})$ (linear for $\varepsilon \ll 1$, saturated at 1); the critical size L_c. [Derived; Appendix A, every number reproducible.]

3.6 The capacity law

$n(x) = 9\sqrt{1+x^2/3}/x^5$ — how many modes a region of size x can carry. It governs the ladder of masses and its bounds (Section 9). [Derived; bracketing theorem in Section 4.]

3.7 The overlap of configurations

W — the overlap of the configurations of two branches of a superposition. An important correction of status: W measures the ORTHOGONALITY of the branches (what a well-separated superposition is), not their decoherence — the medium does not decohere its own excitations (S23, Section 10). W has no closed form in this document: what is established is its role, to measure the orthogonality of the branches, not an expression for it.

3.8 The gravitational coupling — derived

$G = c^4 \cdot \rho_\Lambda/(12\pi\sigma^2)$ — Newton's constant is not an input: it is a relation between the vacuum anchor and the tension. And Newtonian gravity itself is the cross term of the energies: $E_{int} = -E_1E_2/(12\pi\sigma r)$. [Derived; §3.12bis, §3.12ter.]

3.9 The complete potential — the short-range prediction

The potential is Newtonian multiplied by $[1 - e^{(-\sqrt{3}\cdot r/a)}]$ — $\alpha = -1$ exactly, range $\lambda = 16.9$ µm: below the cell scale, gravity switches off. A prediction with no free parameter, compared with the torsion-balance literature. [Derived; §3.12bis.]

3.10 The galactic threshold

10.5281/zenodo.22668459

$a_0 = (5/48)\cdot c^2k = 1.203\times10^{-10}$ m/s² — and below this threshold, $g\_obs/g\_N = 1 + 0.323/\sqrt{x}$. The threshold that other frameworks posit empirically is here derived from the closure curvature. [Derived; §3.7bis.]

3.11 Two consistency identities

The composition of clock rates for several bodies is multiplicative (a direct consequence of the static form of the equation); and the criterion of gravitational stability L_c coincides identically with the Jeans length — the framework recovers the physics of collapse without importing it. [Derived; §0c.7bis.]

4. The theorems

What the framework proves. A theorem is not up for discussion: it is refuted by a counter-example or accepted.

4.1 Theorems of structure

T1 — The junction balance: b = 1. The total area is conserved at the triple junction, and the tension couples only to the singlet. (The framework's central coefficient is not a choice: it is forced.)

T2 — The decomposition $3 = 1 \oplus 2$. The three displacements separate into a stiff singlet — which carries acoustics and gravity — and a soft doublet; the singlet is the heavy generation.

T3 — Mass exclusion: the S_3 symmetry forbids a scalar source — mass — from calling on the doublet, since $1 \otimes 2$ contains no invariant. (Why gravity sees only one channel.)

T4 — The Lorentzian signature is forced by stability (P3) and the persistence of the interface — this is the proof of P6 — and the 3+1 structure of space-time follows (P7). (Space-time is not posited: it is proved.)

T5 — The anchor is insensitive to the finiteness of the universe: the closure residue is of order $(a/R\_\Sigma)^4$, and there is no circularity between ρ_Λ and R_Σ.

4.2 Theorems of gravity

T6 — Exact Newtonian compensation: for the well, the radial and front shares of the tension compensate exactly — mean gravity is rigorously Newtonian; below the threshold, the cross term weighs the area energy alone, to within x/8.

T7 — The identity geometry = gravity: two internal chains with no common ingredient (the energy of the cross term; the eikonal of matter waves) converge — the geometry of Σ is the gravity of masses. Extended sector by sector to equivalence, clocks, light and gravitational waves, whose carrier is the singlet, as their observed non-dispersion requires.

10.5281/zenodo.22668459

T8 — The composition of clock rates gives $g_{00} = -e^{(2\Phi/c^2)}$, hence $\beta = 1$ exactly — and the precession of Mercury recovered: 43.0 arcseconds per century.

T9 — The orientation of the interface is unique — antimatter is never primordial — and the three orientations are fixed at the same stabilisation event. And the correspondence is counted: a 3+1 manifold has exactly three orientations to fix, and there are exactly three discrete symmetries — C, P, T — which the CPT theorem relates.

T10 — At the limits, space and time meet the same fate by co-emergence: what has emerged remains, nothing new emerges — and the joint absence of singularity, horizon and wave collapse entails the conservation of information: the paradox does not arise.

4.3 Theorems of the particle sector

T11 — Opposition: for a resonance driven below its proper frequency, the response is in opposition by exactly 180° — a sign, not an approximate angle: topological, robust against damping. (The sign of charge becomes a fact of structure — Section 7.)

T12 — The bounded scale: $e^K = 295 < 1836 < 3551$ — the proton-to-electron mass ratio is bracketed between two steps of the leptonic ladder: the nucleon is not on the ladder. (Bracketed is not derived — the value 1836 remains a debt, stated plainly.)

T13 — Spin–statistics: an excitation of the two-sided interface carries half-integer spin, and exchanging two such excitations gives −1 — proved by two independent routes (the double cover of the sides; the braiding of windings). What is a verified postulate in the Standard Model is here a theorem of geometry.

T14 — The two bounds of the capacity: the capacity law bounds the exponent of the saddle within the interval [0.382; 0.424] — fixing by theorem what the saddle can and cannot carry in the ladder of masses.

T15 — The rank of the geometric route: the geometric invariants of the interface have rank one or three, never eight — the algebra of forces cannot live in the geometry of Σ; its home is the transport of amplitudes (Section 8).

T16 — Cost preservation: the coefficient of the third invariant ($c_3 = ½$) is not displaced at quadratic order by the non-abelian self-interaction, which begins at cubic order. (The foundation of unification at quadratic order — Section 8.)

T17 — The double topology of charge: $|q_e| = |q_p|$ exactly, through two independent structures (the winding and the side) — an equality of topology, not a tuning. (Verified experimentally to 10^{-21}.)

T18 — The non-locality of the minimum: the minimum of the ladder of masses cannot be carried by any local structure — it is a primitive of the framework (the anchor), not an object to be derived.

10.5281/zenodo.22668459

T19 — Global conservation: $\int_\Sigma T\, dV = 0$. The tension redistributes energy locally but the total sum vanishes — proved by the divergence theorem on a compact Σ without boundary. (P4's "redistributes without creating", proved.)

T20 — The last floor: what crosses the barrier of the limits has lost stability and does not return; no floor of matter can stop the fall before the bottom, by the exponent theorem and the bound c. (The irreversibility of the boundary — the basis of the classicality of degenerate matter.)

T21 — The spatial-to-temporal ratio of the metric equals 1: a theorem of the induced metric — the link that closes $\gamma = 1$ (light is deflected by both shares equally).

T22 — The Gaussianity of the microwave background: the sum of three independent curvature contributions converges to a Gaussian by the central limit theorem — the observed Gaussianity of the CMB is no accident: it is a consequence of $N = 3$, and the central limit theorem intervenes only here.

T23 — A negative theorem, kept in plain sight: a self-similar cascade has no preferred length — none of the internal routes can derive the winding rate R of the lepton sector. It is this theorem that grounds the honest status of the sector: $R^* = 6.266$ is there a MEASURED constant, declared as such, not explained. (A framework that proves what it cannot derive is worth more than one that hides it.)

The calculation appendices allow T8, T12, T14 and T16 to be redone number by number.

5. The source statements

The source material of the framework: statements by the source, dated, set down together with their adversarial reading, from which the calculations then derive the consequences. Each is an assumed physical choice — neither a theorem nor a conjecture: a declared starting point. (The live numbering runs from S9 to S28; S10 does not exist in the document.)

S9 — The three phase differences. The doublet carries three combinations spaced by a third of a turn (120°); they carry charge and IDENTITY, not the mass differences. (The source of the count of generations.)

S11 — Charge on the singlet. The charge of a lepton lives on the total phase — the singlet — blind to the distribution; fullness equals one. (The source of colourlessness.)

S12 — Charge is a torsion of phase. A winding, not a substance. (The source of the spectrum of seven values and of quantisation.)

S13 — The interface and counting. The interface is a geometric result of the crossing of the three fields — two modes, two sides, nothing more; yet it behaves as a medium that counts.

S14 — The half-turn. The "step of space" of the sieve: the structure of the ½ whose holonomy yields $g = 2$ and spin.

10.5281/zenodo.22668459

S15 — The fields are never at rest. σ is not empty: the minimum is a primitive — the anchor ρ_Λ is not derived, it is accepted. (The source of the anchor decision.)

S16 — Full charge, reduced charge. The full charge is the saturated object; the reduced charge is its resonance on the fields. (The unification of S11 and the spectrum.)

S17 — The filling balance. The filling of a loop is relative to the energy level and to local properties; it proceeds to tension saturation; beyond that, the loop subdivides.

S18 — The electron. The electron is the resonance that the nucleon sustains on the fields; no descent in scale connects them, so the question of such a descent does not arise.

S19 — The internal length of a source is the length of its phase. Not a distance in space: the length of the coiled wave — the criterion of the complete turn.

S20 — The complete mechanism source → note. The proton sets the three fields vibrating; on the interface there is an electron — an oscillation of the underlying fields, in opposite phase to the proton (exact opposition: theorem T11).

S21 — The two sides. "A torsion of phase is on one side, the opposite torsion on the other." The sign of charge is geometric: it is the sense of the normal exit. The positron is the torsion of the other side.

S22 — The dilute closure of the saddle. The saddle of a lepton does not close against a wall of its own: it flares out to the first limit of the arena.

S23 — The interface is the sum of the three fields. An excitation exhausts its degrees of freedom, zero-point included. There exists no third party to record the branches of a superposition. (The source of the zero of decoherence — Section 10.)

S24 — The two scales of charge compensation. The proton (net torsion +1) induces a resonance in exact opposition that settles at a distance — the atom. The neutron (zero torsion) compensates internally: its torsions distribute radially, negative at the periphery, positive at the core — no induced resonance. One mechanism of opposition, two scales of compensation. (A consequence verified in sign, with no parameter: the squared charge radius of the neutron is negative, as measured.)

S25 — Spreading by residence. An excitation residing on one field spreads spatially over the cell structure of that field. The three fields being distinct (P1), the spreads of the three windings of a nucleon are independent — their composition is in quadrature; mediation by the interface is that of mass (T3): the mass edge is coherent, the charge edge is threefold. (A consequence, verified blind before it was set down: the width of the charge edge is $\sqrt{3}$ × the local cell — Appendix M.)

S26 — The change of side. The proton, of full presence, changes side while remaining within the interface: it crosses the thickness through the median plane; the emitted electron, of presence 1/16, is what comes out. The cost of the change resums over the attempts to cross the median plane, weighted ½ per side engaged: two sides for a complete change (the proton, 1/12), one for

10.5281/zenodo.22668459

an internal compensation (the neutron, 1/8). The median plane is the same locus as that of the weak energy: half the thickness.

S27 — The presence of sources. The response of the medium at a given scale is carried only by the windings present at that scale: a winding whose proper energy exceeds that of the probe is not resolved and does not count among the sources. The count of sources follows presence — $b_0 = 11 - (2/3)\cdot N$, with N the number of windings present; the energies at which heavy windings become present are their masses, declared.

S28 — The birth of the interface as a countdown of the frame. The interface is born through the differentiation of the twelve rotations of its frame. At the bound, the twelve are one: the frame is entire, and no interface holds above it. Descending from the bound, counted in half-turns of π e-folds from the median plane, each structure separates when the count reaches its own number in the frame: at eleven, the carrier of the fields individuates (sides–fields); at nine, the transitions between the three fields are formed (phase–fields); at eight, the eight gluons exist and each side has made a half-turn in each of the four directions — the interface closes, the mixing angle is fixed.

6. The constants and the anchor

Three anchors fix everything dimensional, and only two of them are measured directly — the economy of the framework, where the Standard Model asks for nineteen parameters. The cosmic anchor is the vacuum energy density, $\rho_\Lambda \approx 5.3\times10^{-10}$ J/m³ — measured, declared (S15): from it follow k, the scales a and λ, R_Σ, the saturation boundary and the galactic threshold. The anchor of matter is the density of matter at the ceiling, ρ_{nuc} — fixed from within, its only measured input being the saturation count n_0: from it follows the nuclear scale $a_{nuc} = 1.0635$ fm. The third anchor is the tension σ, and its value is not measured independently: it is read off gravity, $\sigma = \sqrt{c^4\rho_\Lambda/12\pi G}$, which is why G is an input of everything that passes through it. The interval between the two anchors of scale — L = 24.04 e-folds — is the axis travelled by the interaction photon: it carries the fine-structure constant. Everything that lives between the anchors is deduced; one anchor is never deduced from the other (the cascade theorem forbids it).

$$\rho_\Lambda \rightarrow \sigma,\ k,\ a,\ \lambda,\ R_\Sigma,\ \rho_{max},\ a_0,\ c_a$$

Concretely: the tension $\sigma \approx 4.1\times10^{16}$ J/m² (through $G = c^4\rho_\Lambda/12\pi\sigma^2$), the closure curvature $k = \rho_\Lambda/\sigma$, the cell scale a = 29.2 µm and its reduced value λ = 16.9 µm, the closure radius $R_\Sigma \approx 2.3\times10^{26}$ m, the quantum–classical boundary $\rho_{max} = 27$ g/cm³, the galactic threshold $a_0 = 1.203\times10^{-10}$ m/s², and the proper speed $c_a = c/\sqrt{3}$. None of these numbers is a tuning: all are consequences of the single anchor.

The tower of masses — an honest coordinate system. The minimum (ρ_Λ) is measured and serves as the anchor; the total height of the tower (24.04) is derived; the dense end (1.0635 fm) is measured through the nuclear density; the electron's mark is measured through the electron

10.5281/zenodo.22668459

mass. But the partition of the tower — where the masses sit between the two ends — is not derived, and the document says so plainly rather than dressing it up: it is a coordinate system, not a prediction.

Two sector constants, measured and declared. d = 4.9° (the fluctuation of the generation circle); the winding rate, R = 2π, comes from the dilation–winding identity, a judged source statement (R^* = 6.266 measured, to 0.27 %). One measured constant per sector, stated as such: that is the honest price of the mass sector.

7. Charge and electromagnetism

Charge — a torsion of phase, not a substance. Electric charge is not a “quantity of something” attached to the particle: it is a topological torsion of the phase of the three fields. When the relative phase of a transition between fields winds, the phase difference is constrained — cubed, it equals unity, which permits only three values (the group Z_3). From this comes the complete and closed spectrum of charges:

$$0,\ \pm 1/3,\ \pm 2/3,\ \pm 1 \quad \text{— and nothing else}$$

The fractional values are the windings that reside field by field (the quarks); the integer ones, the windings of the total phase (the leptons). The quantisation of charge — a mystery posited elsewhere — is here a simple fact of topology. (Appendix H)

The sign — the two sides of the interface. The interface has two sides. A source twists the phase on one; the response, on the other, is in exact opposition by 180° — a topological sign, insensitive to damping (theorem T11). The sign of the electron's charge is therefore a fact of structure, not a choice. The positron is the same torsion, read on the other side; and the exact equality $|q_e| = |q_p|$, verified to 10^{-21}, follows from this double topology (T17).

The photon — light is a rotation. The photon is not a field posited: it is the rotation of the internal frame of the three fields along the interface. Its curvature is the commutator of the two ways the interface can bend:

$$F = (i/2)[K_+, K_-]$$

Its vanishing mass is derived (the gauge direction is flat), and so are its two polarisations. The price of its interaction is the third invariant, $c_3 = ½$. The complete derivation — composite nature, two helicities, vanishing mass — is given in Appendix A.

The fine-structure constant — 1/137, from the tower and the angle. The constant that fixes the strength of electromagnetism follows from the geometry:

$$\alpha^{-1} = 2\pi(L - 2)(1 - d^2) = 137.44$$

An offset of 0.3 % from the measured value (residue named). The subtraction of two e-folds is derived: an electromagnetic interaction has two ends — a photon emitted at one, absorbed at

10.5281/zenodo.22668459

the other — and each end weights the path by the force it exerts, in $1/r^2$. On a scale axis this weight decays by a factor e per e-fold, and its centre of gravity falls exactly one e-fold from the end; each vertex therefore removes one e-fold, and there are two of them. And the evolution of the constant with energy — the running — is derived as well: the leptonic slope is $2/(3\pi)$ = 0.2122 per e-fold, obtained from the framework's own spectrum with no virtual particles, with g = 2 native (the holonomy of the half-turn). (Appendices B and C)

8. The three forces

8.1 What the three forces have in common

Unification by the common rule. To unify, in this framework, is not to make three numbers coincide at a point: it is to show that the three forces obey the same rule. The same origin — the three algebras are the three structures of a single frame (the phase, the sides, the fields: 1 + 3 + 8, the twelve rotations), not three groups posited. The same weight at birth — the static cost ½ for each, which every meeting point realises. The same law of variation — each force changes with the fineness of the probe according to the count of its sources present, plus the carrier, a fixed share per winding present weighted by its own charge (S27, with the carrier of each structure at (11/3) times the number of elements it permutes).

The algebra — the three forces come out of a single structure. The geometric invariants of the interface have rank one or three, never eight: the algebra of forces does not live in the geometry of the interface, but in the TRANSPORT of amplitudes. An excitation distributes itself over the three fields (three complex amplitudes); since no field carries a privileged tension, the invariance group is the whole of U(3) — nine rotations — and the two sides carry three more: twelve rotations, one single system:

$$\mathbf{U(3) \times su(2) \;=\; u(1) \oplus su(3) \oplus su(2)}$$

— the algebra of the Standard Model, derived. The strong force is the exact equivalence of the three fields: su(3) exists BECAUSE no field is privileged. At the unification scale, the mixing angle is computed on the charge content of one generation:

$$\mathbf{\sin^2\theta\_W = 3/8}$$

(Appendix C; what this calculation assumes is stated in S.6)

8.2 The electromagnetic force: the phase

The phase is the simplest of the three structures: the singlet, the share common to the three fields, a single generator — u(1). Its charge is the number of windings carried by the phase, integer for a symmetric object (the lepton), fractional for a residence on one field (the quark); its sign is side membership (S21). Its carrier is the photon: the two relative phase differences of the doublet, two polarisations, massless (Section 7). Its strength is the constant α, derived from the

10.5281/zenodo.22668459

interval between the two anchors. Its variation with the fineness of the probe follows the common rule: the phase has no carrier that sees itself (u(1) is abelian), so its slope is the count of sources present alone — a share 2/(3π) per charged winding, weighted by its squared charge and its colours.

$$\alpha^{-1} = 2\pi\cdot(L - 2)\cdot(1 - d^2) = 137.44 \quad \text{(measured 137.04)}$$

The single cost and the two runnings. The cost of the whole system is fixed by a single static weight — the third invariant, $c_3 = \frac{1}{2}$, not displaced at quadratic order (theorem T16). The two opposite runnings follow: matter (fermionic) SCREENS, which is the running of light; the non-abelian carriers (bosonic) ANTISCREEN, which is the sign of asymptotic freedom. The mechanics is explicit — the moment ($3\kappa^2 = 12$) outweighs the orbital term (1), and the eleven emerges:

$$b_0 = 11 - (2/3)\cdot 6 = 7$$

— the measured number of chromodynamics. (Appendices B and D)

8.3 The strong force: the fields

The multiplicities — three colours, counted. A fractional charge must specify its residence: three copies ($N_c = 3$). And the selection rule is derived — fractional ↔ coloured, integer ↔ colourless — which explains why quarks carry colour and leptons do not. (Appendix I)

Gluons — passages, not states. A quark carries a colour: it is a state on a field. A gluon carries a colour AND an anticolour: it is not a state on a field but a TRANSITION from one field to another — a passage. To look for gluons among the states would be a category error; they are among the passages. With three fields, a transition goes from any field to any field, itself included, and the three that change nothing are the diagonal ones:

$$3 \times 3 = 9 \text{ transitions, minus 1 (which changes nothing) } = 8 \text{ gluons}$$

The coupling of gluons to one another follows from the same structure: the commutator of two transitions is again a transition — which is exactly the statement that a gluon couples to a gluon, the three-gluon vertex confirmed by the LEP measurements (and which excludes any abelian gauge theory).

Confinement — why colour is never isolated. A free quark or a free gluon is never observed — only colourless combinations. The framework gives the reason: what decides is not a signed potential but the energy cost of the deformation. The rigidity of the interface has no restoring term, which produces a LINEAR potential:

$$E(r) = T_{restoring} \cdot r$$

Separating two colours then costs an energy that grows without bound with distance: beyond a point, it becomes cheaper to create a new pair than to pull further — colour always stays locked in. The lepton, a colour singlet, has nothing to confine: hence its pointlike character.

10.5281/zenodo.22668459

The strong scale and the field restoring force. The scale of the strong force is not to be derived: it is the second anchor — the ceiling of matter, $\hbar c/a_{nuc}$ = 186 MeV, the order of Λ_{QCD}. Confinement has a native locus: the length beyond which a coloured pattern (an open doublet) can no longer be sustained, $\ell_c = a/\sqrt{3} \approx 0.61$ fm — the reduced cell, the same that sets the edge of nuclei, the short gravitational range and the minimum mass of a black hole.

To separate two colours is to displace two fields relative to one another — the doublet, whose rigidity has no restoring term at large distance: the energy grows in a straight line, each field seeking to return to its place. The form of this restoring force is derived (linear, positive tension with no convention); its magnitude — what chromodynamics calls the string tension, and which is here the constant restoring force of displaced fields — follows from a count of fields.

$$T_{restoring} = 3\sqrt{3}\cdot E_N^2/(8\pi\cdot\hbar c) = 924 \text{ MeV/fm} \quad (\sqrt{T}\cdot\hbar c = 427 \text{ MeV; Regge 420–440})$$

One combination out of twelve falls in the band; the three choices are motivated before the number; it is a strong candidate, stated as such — what is missing for “derived” is a second independent judge and the derivation of the weight of the source from the equation.

The nucleon mass. The response of the interface is $3\sigma q^2 + \kappa q^4$: the tension (the singlet) dominates at large scales, the rigidity (the doublet) at small ones; they meet and cross over at the locus, $\ell_c = a/\sqrt{3}$ — the only place on the scale axis where an object made of three fields pays neither the surcharge of the one nor of the other. A residence — a coloured winding — lives on the doublet, whose length this is; it carries the energy of the locus, $\hbar c/\ell_c$ = 321 MeV. The nucleon is three residences, one per field:

$$E_N = 3\cdot\hbar c/\ell_c = 3\sqrt{3}\cdot\hbar c/a = 964 \text{ MeV} \quad (\text{measured 939; +2.7 \%}) \quad ; \quad \text{with no mass as input: } m_N = (3\sqrt{3})^{4/3}\cdot\hbar c\cdot n_0^{1/3} = 964 \text{ MeV}$$

The saturation density n_0 is a number per volume, with no mass: the nucleon mass comes out of it alone, to 3 %. The framework's single wall — the absolute mass, the ratio 1836 — is opened from above, as it was for the electron: not from the internal grammar, but from a locus on the scale axis. Status: strong candidate (the proton and the neutron, the same count; the alternatives far away); the 2–3 % is the precision of the anchor.

The force between two colours at short distance follows from a candidate mechanism: the response of the medium to a probe (the running coupling), weighted by the presence of the colour being displaced — one turn of the colour cell costs one half of presence per half-turn, as for every object of the framework: the colour at the edge of its cell is there only one time in four. With this single factor, the force measured on the lattice from 0.05 to 0.6 fm is reproduced to 5 %, with no parameter.

$$F(r) = T + (4/3)\cdot\alpha(\hbar c/r)\cdot f(r)\cdot\hbar c/r^2 \quad \text{with} \quad f(r) = (1/2)^{2r/\ell_c}$$

8.4 The weak force: the sides

10.5281/zenodo.22668459

The weak energy — what it is, seen from the interface. The reader knows the weak force in its standard form: a very short-range interaction, carried by the W and Z bosons (80 and 91 GeV), whose effective low-energy strength is the Fermi constant $G_F \approx 1.17\times10^{-5}$ GeV^{-2}, and whose scale — 246 GeV — is posited by the Higgs mechanism without anything explaining its value. The framework takes each of these objects and gives it a locus. The weak force is the change of side of a winding: the interface has two geometrically distinct sides, side membership is the charge (S21), and the charged current — electron ↔ neutrino, the transformation of the neutron into a proton — is the displacement of a winding from one side to the other, within the interface (S26).

The weak scale is the median plane. To change side, a winding crosses the thickness of the interface — counted in e-folds of scale between its two anchors (the tower, L = 24.04 e-folds, the same quantity that carries the fine-structure constant) — and it flips at the median plane, the only locus that privileges neither of the two equivalent sides. The weak energy is therefore the energy needed to carry the limit object of the interface — the electron, at the presence bound (1/16) — up to that median plane: L/2 e-folds above its rest energy.

$$E_{median} = m_e \cdot e^{(L/2)} = 0.511\ \text{MeV} \cdot e^{(12.018)} = 84.7\ \text{GeV}$$

This number is neither the W nor the Z: it is their geometric mean, $\sqrt{M_W \cdot M_Z}$ = 85.6 GeV, to 1.1 % — the scale of the side carrier before the mixing angle divides it into charged and neutral. The angle, derived (3/8 at unification, brought down to 0.231), does the rest: M_W = 79.6 GeV (−1.0 %), M_Z = 90.3 GeV (−1.0 %), v = 244.3 GeV (−0.8 %), $G_F = 1.185\times10^{-5}$ GeV^{-2} (+1.6 %). The weak scale, a free input of the Standard Model, becomes a consequence of the framework's anchors, the electron mass and the geometry of the two sides.

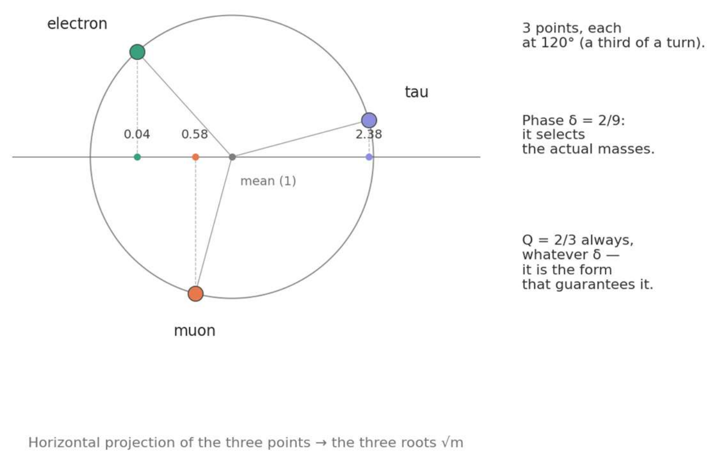
9. Matter

Mass lives on the singlet — and on it alone. The whole energy of an object — for a nucleon, its quarks, its colour binding, everything that constitutes it — is, for the interface, a simple scalar density. But a scalar source can call on only one of the two modes: the singlet. The doublet receives nothing — not because some share of the energy is reserved for it and lost, but because it does not couple: the symmetry of the three fields forbids a scalar source from touching the doublet (the product $1 \otimes 2$ contains no invariant). Mass is therefore, literally, what the singlet carries.

The leptons. The electron is the resonance that the nucleon sustains on the fields (S18), and the complete mechanism is written out. The mass sector carries its derived form and two declared measured constants (R*, d); under the dilation–winding identity, the Koide relation (Q = 2/3 to 10^{-5}) is derived and the tau predicted from the electron and the muon. Spin ½ and antisymmetry are theorems (T13):

$$\text{Ratio} = 8/15 \times (1 - d^2), \quad \text{with } d = 4.9° \text{ measured}$$

10.5281/zenodo.22668459



The Koide circle. The three leptons occupy three points at 120°; their horizontal projections are the three √m (mean 1). The amplitude √2 guarantees Q = 2/3 for any phase; the phase δ = 2/9 selects the actual masses.

The nucleon. The nucleon is matter at saturation — the interface filled at the nuclear scale, confined and therefore extended (~1 fm), carrying the full charge. It is not on the leptonic ladder (T12): its mass ratio to the electron, 1836, is bracketed, not derived, and the document says so. The neutrino, for its part, is predicted to be its own antiparticle (Majorana) — falsifiable by neutrinoless double beta decay.

The proton. A uud composite of the derived spectrum of charges — three phase windings, one per field (the residence, closed off by the selection rule: colour neutrality). Its charge is computed from the spectrum, each value being a theorem of the Z_3 centre (Appendix H) — exact, topological, with no error bar: a source of net torsion +1, which induces exactly one resonance in opposition — the electron: the atom is the compensation closed at a distance.

$$q_p = +2/3 + 2/3 - 1/3 = +1 \qquad \text{(verified: } |q_p| = |q_e| \text{ to } 10^{-21}\text{)}$$

The charge radius of the proton, computed. The same reading yields a number: the charge core at the proton's own cell (fixed by its energy), the periphery at the cell of nuclear saturation, the component projected far away — the electron — subtracted: the charge radius comes out 2.8 % below the measurement, with no parameter. The residue has a structural explanation and, since then, a number: the proton's compensation being projected across the interface (a change of side), its peripheral layer tightens by a fraction fixed by the two presence bounds of the lepton sector — that of the electron (1/16) resummed over the muon threshold (½) crossed twice, once per side: f = (1/16)/(1 − ¼) = 1/12. With this fraction, $\langle r^2\rangle_p$ = 0.7067 fm² against 0.7071 measured: −0.1 %.

10.5281/zenodo.22668459

The neutron. A udd composite of the same spectrum — three windings, one per field. The calculation, from the same theorem (Appendix H):

$$q_n = +2/3 - 1/3 - 1/3 = 0 \qquad \text{(verified: neutrality below } 10^{-21}\text{ e)}$$

The reading of the two records holds in one sentence (S24): one mechanism of opposition, two scales of compensation — the atom for the proton, the surface layer for the neutron. A first consequence, verified in sign with no parameter: the squared charge radius of the neutron is negative (positive core, negative periphery). And its magnitude is computed from the same two bounds as the proton, with the exponent that S24 imposes — the compensation being internal, the threshold is crossed only once: $f = (1/16)/(1 - ½) = 1/8$ — whence $\langle r^2\rangle_n = -0.117$ fm² against −0.116 measured: +0.5 %. The neutron judges the exponent of the mechanism — with the reservation stated in S.2, the nucleon energy entering it as a measured value: swapping the exponents shifts it by 18 %.

Atoms and nuclei. The filling numbers of the electron shells are derived from spherical symmetry and spin — where standard physics observes them without deriving them:

$$2,\ 8,\ 18,\ 32 \quad (= 2n^2)$$

On the nuclear side: the constant charge radius of the calcium isotopes (the saturating response of the tension), the discrete structure of the radii at shell closures (909 isotopes analysed), the magic numbers reproduced with spin–orbit read as surface curvature, and the charge radius of the proton, which the framework predicts does not depend on the probe: the radius is a property of the object, and the muonic and electronic determinations must give the same value. The frontier of the sector, the King plots, is a falsifiable prediction (Section 12).

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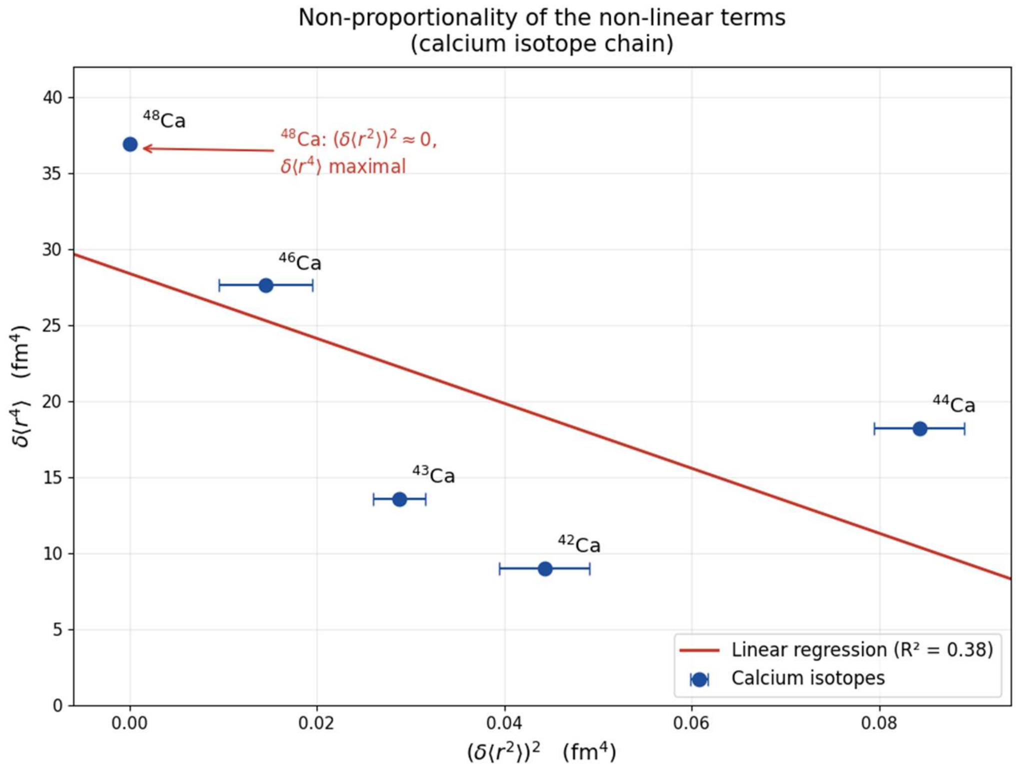

The calcium isotope chain: δ⟨r⁴⟩ against (δ⟨r²⟩)². ⁴⁸Ca stands apart — constant charge radius, saturating response — the non-proportionality the framework predicts.

The edge of nuclei — the surface term (S25). Conservation of volume with a spread edge reduces the effective charge radius (R_q), not the density radius; the width of the edge follows S25: three windings, three independent spreads, composition in quadrature — √3 times the local cell. A blind fit to the measured charge radii gives z = 0.36–0.43 fm, bracketing the predicted value and excluding simple smoothing (0.23). Full derivation, RMS judgement and statuses: Appendix M.

$$C(A) = a_{nuc}\cdot A^{1/3}\cdot[1 - \pi^2 z^2/(3a_{nuc}^2 A^{2/3})], \quad z = \sqrt{3}\cdot a_{loc}/4.394 = 0.402\ \text{fm}$$

What holds the nucleus together — the valley of stability. Nothing attracts the nucleons: at saturation density they are a single cascade of contiguous cells, with no gaps.

What could undo it is the proton: its compensation is projected far away (the electron), so inside the nucleus its positive core is bare, and two neighbouring protons are two net torsions of the same sense which add — their cost is derived: $a_c = (3/5)\cdot\alpha\cdot\hbar c/r_0$. The neutron, compensated on its own surface, is neutral; it separates the protons without net torsion.

What forbids adding neutrons without end is the asymmetry cost, in two native parts: exclusion (two species on two scales) and the proton–neutron crossing at the median plane (Section 8: a single attempt, the bare bound f_e = 1/16 of the peripheral shell: 20.8 MeV). The formulas for

10.5281/zenodo.22668459

these costs are uniform-sphere formulas: their radius is the equivalent uniform sphere, r_0 = 1.20 fm — a charge radius, R_q. Why this radius differs from the matter anchor, 1.0635 fm, must be said: these are not two conventions for the same object, they are two different extents. Density lives on the singlet, charge on the doublet; a charge radius and a density radius therefore do not measure the same mode, and nothing requires them to coincide.

The neutron skin — a consequence, tested. Since charge follows the protons and density follows all the nucleons, the density radius must exceed the charge radius in proportion to the neutron excess, and the difference must vanish exactly at N = Z. On six measured nuclei — calcium-40, nickel-58, tin-116, calcium-48, tin-124, lead-208 — the correlation is 0.914, the slope 0.915 ± 0.076 fm, and calcium-40, at N = Z, gives a skin consistent with zero. The framework delivers the sign, the law and the control point; it does not yet deliver the slope, which would require the profile of the two modes within the nucleus.

What remains owed: the thickness δ of the asymmetry layer at this scale (the free fit 0.74 fm, close to the reduced cell 0.69), and the regime of light nuclei (the shell structure in plateaux at the magic numbers). Appendix P.

10. The quantum

Superposition — the heart of quantum mechanics, native. An excitation distributes itself in amplitude over the three fields, and this very possibility is the source of the framework's continuity. The amplitude is complex; the products amplitude × conjugate form the Hermitian structure (the one that already gave the eight gluons); the field equation, linear and energy-conserving, carries unitarity. The framework therefore contains natively the mathematical heart of quantum mechanics — it does not borrow it.

The boundary — where the quantum yields to the classical. The interface is the sum of the three fields; an excitation exhausts its degrees of freedom, zero-point included (S23): no third party exists to record the branches — the overlap W measures their orthogonality, not their death. Intrinsic decoherence is strictly zero below a saturation boundary in density:

$$\rho\_max = 27 \text{ g/cm}^3$$

Below it — that is, for every laboratory object, subcritical by several orders — superpositions are preserved, exactly as in standard quantum mechanics. The framework's only quantum–classical limit is the threshold at which linearity, which IS the superposition principle, ceases. (Appendix E)

Measurement and entanglement. What is called the collapse of the wave function is a limitation of the measurement: a detection is local and bears on an excitation present across several fields (P5) — there is no physical collapse. And two entangled particles are the same wave, projected in several places through the deep geometry of the fields — not action at a distance. The tensor

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support ($\mathbb{C}^3 \otimes \mathbb{C}^3$) is native; the quantitative correlations remain contingent on the Born rule, named as a debt.

11. Gravitation and cosmology

Gravity — geometry IS gravity. Newton's constant is derived from the anchor, and Newtonian gravity is the cross term of the energies, rigorously Newtonian on average (T6):

$$G = c^4\rho\_\Lambda / 12\pi\sigma^2$$

Two internal chains with no common ingredient converge to establish that the geometry of the interface IS the gravity of masses (T7) — an identity extended to equivalence, to clocks, to the deflection of light and to gravitational waves (carried by the singlet, non-dispersive). The post-Newtonian gauges come out exact:

$$\gamma = 1, \quad \beta = 1 \quad \rightarrow \quad \text{Mercury: } 43.0'' \text{ per century}$$

And a short-range prediction, with no free parameter: the potential switches off below the cell scale, as Newtonian × [1 − e^(−√3r/a)], of range 16.9 µm.

Galaxies — without dark matter. The acceleration threshold of galaxies, which other frameworks posit, is here derived from the anchor:

$$a_0 = (5/48)\cdot c^2\cdot k = 1.203\times10^{-10}\ \text{m/s}^2 \quad ; \quad g\_obs/g\_N = 1 + 0.323/\sqrt{x}$$

The flat rotation curve is a consequence, with no substance added: lensing follows the dynamics by construction. The mechanism reproduces galaxies; clusters remain in deficit — the classic wall of every law of this kind, which the framework does not dodge. The decisive test is on record: wide binaries (Section 12). (Appendix F)

Cosmology. The anchor ρ_Λ is the zero-point cut off at its proper scale — local, insensitive to the finiteness of the universe (T5). The Hubble constant and the galactic threshold proceed from a single quantity:

$$H_0 \text{ and } a_0 \text{ proceed from } k\cdot c$$

The framework's number lies between the two conflicting determinations of the Hubble tension. The Gaussianity of the microwave background is a consequence of N = 3 (T22), and its structure at large angles is compared with the observed anomalies. The Big Bang is reread as the stabilisation of the intersection (a reinterpretation, status declared). Black holes have neither singularity nor horizon and information is conserved in them (T10) — their fine signatures remaining declared speculative. And degenerate matter, beyond the saturation boundary, has crossed the barrier: white dwarfs and neutron stars are, as regards the delocalisation of their centre of mass, intrinsically classical.

The minimum mass of a black hole. The curvature ceiling of the interface (Tr(K) ≤ √3/a, derived) forbids any black hole of radius smaller than a_min = 16.9 µm: M_min = 1.1×10^{22} kg — the mass

10.5281/zenodo.22668459

of a large asteroid packed into seventeen microns, a hundred to a thousand times above the window in which primordial black holes could constitute dark matter. Two consequences with no borrowing from Hawking radiation: no final evaporation burst, ever; and the “asteroid” window is empty. The classic questions of remnants (entropy, pair production) remain open, stated as such.

The absence of baryogenesis — why the universe is made of matter. The standard account must explain why the universe contains matter and almost no antimatter: it posits baryogenesis — a mechanism creating a slight excess of matter, requiring the Sakharov conditions. No satisfactory mechanism has been found. The framework reverses the question: the interface settled in a single event, which fixed one orientation of the three fields. This stabilisation produced matter, and did NOT create antimatter — antimatter is the other side, never populated primordially. There is therefore no imbalance to explain: no asymmetry, no baryogenesis.

The uniformity of the microwave background, without inflation. The microwave background has the same temperature in all directions to one part in a hundred thousand, including between regions which, in the standard Big Bang, can never have been in causal contact — the horizon problem, which the standard model solves by postulating inflation. The framework offers another route: uniformity is an effect of the stabilisation of the interface over a large surface in a single act, and the fluctuations are the residue of geometric cancellations between the three fields. Honest status: the mechanism is structurally coherent but not yet quantitative — reproducing the amplitude of the fluctuations and the position of the acoustic peaks remains the great unmet challenge.

Black-hole evaporation — a remnant. If a black hole evaporates by Hawking radiation, the framework expects the process to stop (or to change regime) when the size reaches the saturation floor of the tension: a remnant of finite size would be left, rather than a complete disappearance. Named reservation: the framework offers a geometric mechanism for this minimum size, but does not resolve the known problems of entropy and pair production — and does not claim to.

12. The catalogue of falsifiable predictions

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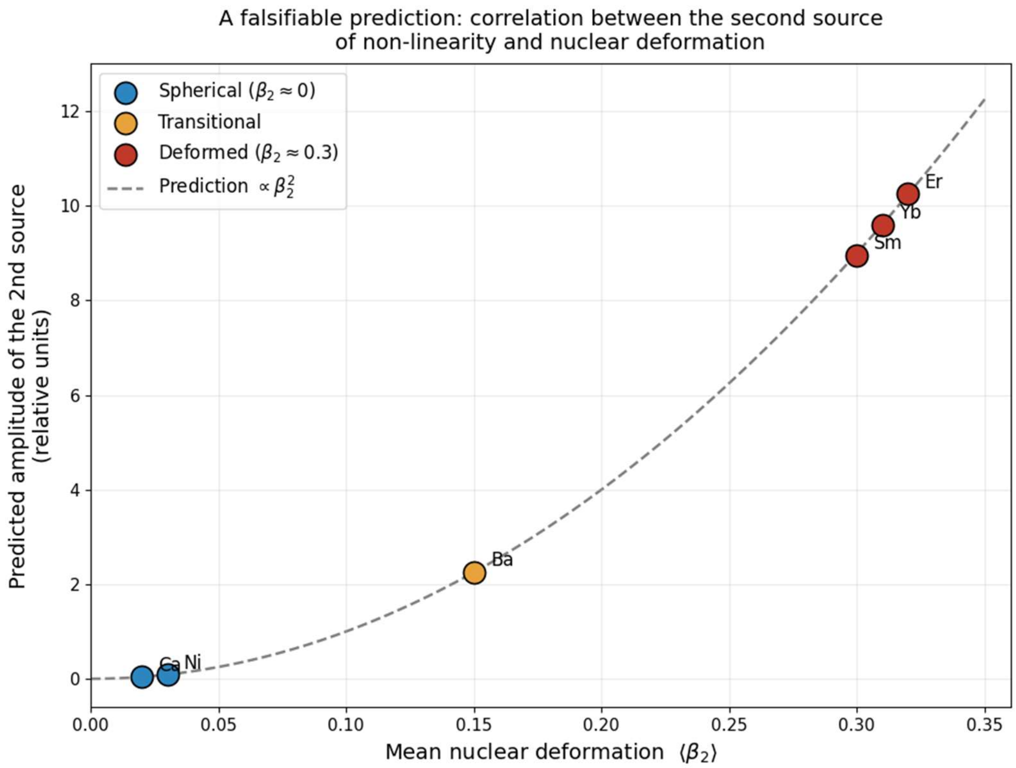


A falsifiable prediction: the amplitude of the second source of non-linearity grows as the square of the nuclear deformation ($\propto \beta_2^2$) — spherical nuclei below, deformed nuclei above.

In order of due date. Each prediction carries its judge, its date, and what would kill it.

1. Wide binaries (Gaia DR4, late 2026 — THE prediction, placed on record on 18 August 2026). The fork: the boost γ is 0.323 (reading A) or 0.305 (reading B) in the anomaly zone — an A/B difference of 1.3 to 2.2 %. The empirical state before DR4: on cleaned eDR3, the clean data are Newtonian out to ~10 kAU — consistent with the framework's late transition ($r_t \approx 3.6$ kAU), UNFAVOURABLE to MOND, and the distinctive plateau (γ ~ 1.6 beyond 14 kAU) is out of reach of 2D velocities: it awaits DR4. What kills it: a Newtonian sky everywhere at DR4.

2. The neutrino with no polarity: the structural conclusion is falsifiable and is currently being tested by experiments under way.

3. King plots: the non-linearity predicted where standard theory requires a straight line — with its precise form and the transverse test of nuclear deformation in the framework document.

4. Short-range gravity: the extinction of the potential below 16.9 µm (α = −1 exactly) — compared with the torsion-balance literature; conditional, with no free parameter.

5. Decoherence: intrinsically zero below the boundary — the dated wager against spontaneous-collapse models (which predict a rate in the 10^6–10^{10} amu range of the interferometers under preparation). What kills it: a reproducible residual excess after instrumental subtraction, at any mass.

10.5281/zenodo.22668459

6. The Gaussianity of the CMB as a consequence of N = 3, and the modal structure at large angles.

7. The minimum mass of a black hole: no black hole below 1.1×10^{22} kg (16.9 µm). What kills it: the detection of an evaporating primordial black hole (an end-of-life gamma burst, Fermi/HAWC), or of a black hole below the threshold mass by microlensing.

8. Unification without proton decay: the framework obtains the mixing angle at unification ($\sin^2\theta_W = 3/8$) from three distinct structures of the interface — with no generator mixing quarks and leptons, hence no proton decay. Group unifications cannot do this: they pay for the angle with a proton that dies, and the Super-Kamiokande bound ($\tau > 1.6 \times 10^{34}$ years) forces them above 10^{15} GeV, where the angle misses the measurement without supersymmetry. What kills it: a single $p \to e^+\pi^0$ event would kill the group theories and leave the framework standing.

9. The vacuum share: $\Omega_\Lambda = 2/3$ exactly. Judge: Ω_Λ measured = 0.6847 ± 0.0073 (Planck 2018); 2/3 = 0.667, an offset of 2.7 % — 2.5σ: a tension, not an agreement. Status: derived by two converging routes — the expansion ($H = \sqrt{3} \cdot c/R_\Sigma$, §3.12) and the phase equipartition of the three modes (S14) — with no posited step. What kills it: a measurement of Ω_Λ moving away from 2/3 beyond the framework's margin (the precision of σ, 2 %); what would save it: a mechanism for the third, or a native correction. What the framework does not claim: to have derived the age of the universe — the age follows from $\Omega_\Lambda = 2/3$ as in any cosmology.

10. The temperature of the microwave background: $T_{CMB} = T_\Lambda \cdot e^{(-3\pi/4)} = 2.742$ K. The ratio between the vacuum density and that of the fossil radiation is $e^{(3\pi)}$ — three half-turns of π in density, one per field. Judge: T_{CMB} = 2.7255 ± 0.0006 K; predicted 2.742, an offset of +0.6 %, within the margin of ρ_Λ. Status: candidate mechanism. What kills it: a tightened measurement of ρ_Λ moving T_Λ out of agreement. What the framework does not claim: standard cosmology does not relate T_{CMB} to ρ_Λ — this is a new relation, not a reproduction.

11. Primordial helium: $Y_p = 63/256 = 0.2461$ — from the presence of the neutron's internal compensation ($f_n = 1/8$) and the weight of one attempt at a change of side (1/64), with no duration and no parameter; measured 0.2458 ± 0.0013 (+0.2σ). What kills it: a measurement of Y_p below 0.242 or above 0.250. What is not claimed: that the charge radius of the neutron is a second judge of the same object.

12. The neutron skin: in a nucleus, the density radius exceeds the charge radius in proportion to the neutron excess, and the difference vanishes exactly at N = Z. A direct consequence of the distinction between the two modes — charge on the doublet, density on the singlet — costing no parameter. Verified on six nuclei (correlation 0.914; calcium-40 consistent with zero). What kills it: a non-zero skin measured on a nucleus with N = Z, or a skin that did not grow with the neutron excess. What the framework does not yet deliver: the slope, 0.92 fm.

And the permanent counter-example: every theorem (Section 4) is refutable by counter-example — the framework keeps its door open.

10.5281/zenodo.22668459

13. The register of debts, in plain sight

What is not derived, named and dated. The statuses used: derived, theorem, emergent, relation, strong candidate, candidate, reading, source statement, debt, held back.

The source statements of the framework, posited and judged, not derived: the dilation–winding identity (one e-fold of density and one turn of phase are a single motion; it fixes $R = 2\pi$; judged by the leptonic saddle to 0.27 %, the running of the photon, Planck, the meeting points, the microwave background); S24 (the two scales of compensation); S25 (the $\sqrt{3}$ edge); S26 (the change of side) and its rule of attempts — the ½ per side engaged is derived from phase equipartition, a side being one sense of the normal and leaving through it a half-turn; S27 (the presence of sources); S28 (the birth as a countdown of the frame — why eleven, nine and eight: the numbers of the frame, the rule "each structure at its own number" posited).

The mass sector: the angle $d = 4.9°$ (the fluctuation; its form is derived, and its value now comes out of the closure of α under the zero-point fluctuation conjecture — see S.5); the electron mass from the anchors (0.509 MeV, −0.4 % — strong candidate; two posited pieces: the conversion of the half-turn, the median at L/2 above the limit object); the nucleon mass from the locus (964 MeV, +2.7 % — strong candidate); the ratio 1836 follows as the ratio of two masses held by the anchors, to their precision; the mass differences between generations: the position ↔ mass relation is circular, and the framework does not pursue it; the Koide criterion ($Q = 2/3$ to 10^{-5}), derived under the dilation–winding identity, no further.

The gauge sector: the sides → doublet bridge; the distinction between the two Z_3; the electroweak scale (the median plane, $m_e \cdot e^{(L/2)}$, to 1.1 % — strong candidate under two named readings); the W and Z masses computed through the derived angle (1.1 %); the complete normalisation of the gauge structure is not written; the pattern factor and the restoring force: strong candidates, not exclusive within the ± 9 % margin of the target.

The nuclear sector: the packing factor $r_0 = a_{nuc} \cdot 2^{(1/6)}$ is a borrowing — the 0.74 in it is the close-packing fraction of hard spheres, a geometry external to the framework; the number agrees to 0.5 % with the observed charge radius, but with no native mechanism, and it must not be used to count a volume; the pairing coefficient ($W = 3 \cdot E_{cross}$ — strong candidate); the width of the shell plateaux at the magic numbers; the resonance/valley discrepancy (15–20 %); the ~10 % of S_0.

Cosmology: R_Σ is measured, not derived — the framework gains a relation between three quantities; $\Omega_\Lambda = 2/3$, derived, is in tension at 2.5σ with the fitted parameter of ΛCDM — the direct comparison on the observables remains to be done; the distant universe: dilution by cells delivers the density, the temperature and the supernova diagram; the composition of stabilisation — primordial helium: a strong candidate, with its two named readings; deuterium depends on the number of windings, a measured content — not a debt; lithium is set aside.

10.5281/zenodo.22668459

The quantum: the Born rule as probability (the energy → probability bridge) and the measurement problem — two debts shared with all of physics; the density-matrix proof of S23 (a named worksite).

Gravity: the complete non-linear order (begun — linear gravity, finiteness, survival of the scale, $\beta = \gamma = 1$ — not completed); the fine signatures of black holes (speculative, stated as such).

The programmes: P8 (the arithmetic correspondence — the Berry–Keating identification is declared obstructed); the integer subdivision of cells.

Withdrawn from this list, as questions posed in the vocabulary of another theory: the group factors (the carrier weighs 11/3 per permuted element); the higher orders of the running (the framework's law is closed, one slope per e-fold; the offset at the Z is one of convention).

Debts open as of 7 September 2026, in order of what they cost. The charge radii of the proton and the neutron are computed only with the measured nucleon energy: with the derived energy, the neutron departs by 23 % — the shell length of the calculation has not been harmonised with the cell (S.2). The offset of 2.7 % carried by the nuclear cell recurs wherever it enters — the nucleon energy, the saturation density — without being explained (S.14). The median plane, in the native chain, falls 1.5 % below the geometric mean of the weak boson masses, and no remaining choice moves it. The scale from which the mixing angle descends is read off the measured angle, and it lies some thirty e-folds above the nuclear ceiling — where the framework has no cell (S.6). The identity of the two roles of the presence 1/8 — a resummation cost on one side, a frequency of realisation on the other — is not demonstrated (S.11). The photon as a state of the doublet is not treated beyond quadratic order (S.9). And the abundance of lithium is set aside.

The framework names its debts, proves them when it can, and dates them. The detail of each, with the numbers, is in Appendix S — written so that this document can be read on its own.

10.5281/zenodo.22668459

Appendix A — Light: complete derivation

In the Standard Model, the photon is an elementary field posited: its two polarisations, its vanishing mass and its coupling are given. Here none of that is posited — the photon is a consequence of the geometry of the interface. This appendix derives, step by step, its nature, its curvature, its two polarisations and its vanishing mass, and names honestly what remains owed.

1. The geometric setting. At each point of the interface Σ there lives an internal frame of the three fields. This frame may rotate from point to point; that rotation is the gauge connection A. It is not added by hand: it is a datum of the geometric background. The soft sector — the doublet — carries exactly two real transverse modes, d_1 and d_2.

2. The photon is composite. The potential A is quadratic in the displacements of the doublet: the gauge quantum is a two-quantum state of the soft sector, not a fundamental field. This is already a prediction — the carrier is not elementary.

3. The curvature is a commutator (the Ricci equation). By the Ricci equation of immersions — a theorem of differential geometry applied to the objects the framework defines — the curvature of this connection is written

$$\mathbf{F = [K_1, K_2] = (i/2)[K_+, K_-]}$$

the commutator of the two shape operators of the doublet, that is, of the two ways in which the interface can bend.

4. Why this is the electromagnetic field. The two modes of the doublet commute as directions — hence abelianity, a single U(1). But their curvatures do not commute, and this failure to commute IS the electromagnetic field. In one sentence: light is the failure to commute of the two ways in which the interface can bend. The group U(1) is not posited; it follows from the commutativity of the directions.

5. The two polarisations (derived). The doublet has exactly two real transverse modes, d_1 and d_2. Their complex combinations $z = d_1 + i \cdot d_2$ and $\bar{z} = d_1 - i \cdot d_2$ are exactly the form of the two helicities of the photon (the circular polarisations). Under U(1): $z \to e^{(i\theta)}z$ and $\bar{z} \to e^{(-i\theta)}\bar{z}$ — opposite helicity charges ±1, exactly the behaviour of the two polarisations. The number of states (2), their form and their gauge transformation are therefore derived, where the Standard Model posits them.

6. The vanishing mass (derived). The gauge redundancy $A \to A + d\theta$ is exact — established by the normal-bundle theorem. The vanishing mass of the carrier is protected by this invariance: no mass term is invariant, so the photon cannot weigh. The gauge direction is flat — deforming it costs nothing at quadratic order.

Consistency check. Each piece rests on an object of the framework — the two-mode doublet, the Ricci equation (an applied theorem), the commutativity of the directions (U(1)), gauge invariance (the normal-bundle theorem). No element is imported from the Standard Model.

10.5281/zenodo.22668459

What remains owed, named. The STRUCTURE of light is derived — composite, curvature as commutator, two polarisations, vanishing mass. The STRENGTH of its interaction — the fine-structure constant α — is reproduced to 0.3 % by the geometric formula $\alpha^{-1} = 2\pi(L-2)(1-d^2) = 137.44$, but its deep derivation from the invariants of the action retains open pieces (the coefficient of the third invariant, the low-energy matching). The framework therefore knows what its light is, its states and its vanishing mass; the exact price of its interaction it names as a debt rather than inventing it.

10.5281/zenodo.22668459

Appendix B — The running of α: the slope 2/3π, without virtual particles

In quantum electrodynamics, the increase of α with energy (the running) comes from vacuum polarisation by virtual particle–antiparticle pairs. Here there are no virtual particles: the running comes out of the framework's own spectrum.

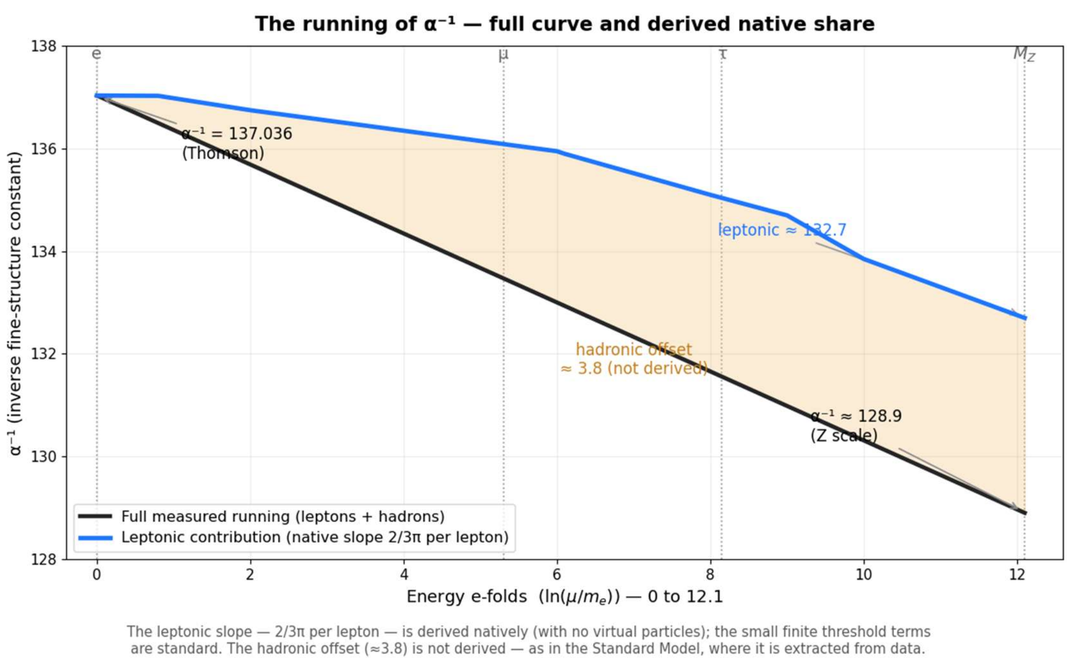
1. The charged note. A lepton is a relativistic winding on the interface (the singlet, dispersion $\omega = c \cdot q$). Immersed in a uniform field F, its energy levels form a Landau-type spectrum, $\omega^2 = B(2n+1) - \sigma\kappa B$ ($n = 0, 1, 2 \dots$).

2. The kernel, drawn from the spectrum. Summing the spectrum in proper time is an exact geometric series: it gives the kernel $x \cdot \coth(x)$ — derived from the spectrum, not borrowed from Euler–Heisenberg. The coefficient of x^2 in its expansion is 1/3.

3. The slope. The coefficient 1/3 gives the response weight w = 4/3, whence the slope of the running

$$\mathbf{d\alpha^{-1}/d(e\text{-fold}) = w/(2\pi) = (4/3)/(2\pi) = 2/(3\pi) = 0.2122}$$

— a rational value, exact.



The leptonic running of α^{-1}, derived from the framework's own spectrum: the slope 2/(3π) per e-fold, with no virtual particles.

10.5281/zenodo.22668459

4. The three inputs, all derived or read. $\kappa = 1$ (derived by holonomy) gives the spin term; $N_{ap} = 2$ (the two sides count at the zero-point of the volume, read from S20: the note is an oscillation of the underlying fields); the fermionic sign is derived by a pincer of two independent topological routes — the double cover of the two sides ($2\pi \to -1$) and the half-braiding of two unit windings ($\pi \to -1$) — converging on antisymmetry.

Check. $2/(3\pi) = 0.21221$; the leptonic slope measured per e-fold is 0.21218 — an exact structural agreement (the number is rational on both sides).

What is derived, and what is not. The STRUCTURE (the coth kernel) and the statistical SIGN are derived; the chain is closed with no free choice. But this is a CONVERGENCE — the framework recovers the standard value $2/3\pi$, it does not surpass it; the absolute scale passes through an instrument calibration (the scalar standard); and the hadronic part of the full running remains borrowed, as in the Standard Model where it is extracted from data. An alternative native derivation of a known result, without virtual particles and without an adjusted knob.

10.5281/zenodo.22668459

Appendix C — The mixing angle (known as the Weinberg angle): $\sin^2\theta\_W = 3/8$

The mixing angle governs the division between the electromagnetic and weak forces. The Standard Model measures it; here it is computed on the structure of the charges.

1. The charges. The structure of the frame gives the electric charge operator Q and the weak isospin T_3, with the fractional charges (0, ±1/3, ±2/3, ±1) derived from the Z_3 constraint on the relative phase of the three fields.

2. The ratio. $\sin^2\theta\_W = Tr(T_3^2)/Tr(Q^2)$, the sum over the multiplet of generators. One obtains $Tr(T_3^2) = 2$ and $Tr(Q^2) = 16/3$, whence

$$\sin^2\theta\_W = Tr(T_3^2)/Tr(Q^2) = 2/(16/3) = 3/8 = 0.375$$

What is derived, and the honesty about scale. 3/8 is the canonical value at the unification scale, drawn from the structure of the charges in thirds alone, WITH NO unifying group postulated. It is not the value measured at low energy (≈ 0.231 at the Z scale): the difference is the effect of the renormalisation flow over some fifteen orders of magnitude. The framework claims 3/8 at the scale of the genesis; the matching to the measured value requires the running (which Appendix B makes native — the two results support one another). What the calculation assumes is stated in S.6: the trace is taken over the charge content of one complete generation, which particle physics has established.

10.5281/zenodo.22668459

Appendix D — The coefficient of the strong force: $b_0 = 11 - 4 = 7$

The strong force grows with distance (asymptotic freedom, Nobel 2004) — the reverse of electromagnetism. The coefficient b_0 governs this sense. The Standard Model measures it; here it is decomposed and derived.

1. The formula, with $n\_f = 2 \cdot N\_gen = 6$ (six quark flavours, from three generations at two each):

$$\mathbf{b_0 = 11 - (2/3) \cdot n\_f = 11 - 4 = 7}$$

the eleven coming from the carrier, the four from the content.

2. The eleven (the carrier). The self-interaction of the carrier emerges from the spectrum of turns, decomposed: 11 = 12 (moment) − 1 (orbital). This is the 11 of chromodynamics ($b_0 = 11N/3$ with $N = 3$).

3. The result. The SENSE (antiscreening) and both numbers (11 from the carrier, 4 from the content) are derived.

What remains owed. The carrier weighs 11/3 per permuted element — three fields, two sides — and the coincidence with the SU(3) normalisation is a consequence of the derived algebra, not a borrowing; the judge of the result is the STRUCTURE (the sign and the eleven), not the group normalisation.

10.5281/zenodo.22668459

Appendix E — The quantum–classical boundary: ρ_max = √3σ/(a c²) = 27 g/cm³

What makes a superposition decohere? In the framework it is not coupling to the environment, but a threshold in density — beyond which an object is classical.

1. The formula, where σ is the tension of the interface, a its proper scale, c the speed of light:

$$\rho_{max} = \sqrt{3}\cdot\sigma/(a\cdot c^2) = 27.0\ \mathrm{g/cm^3}$$

2. Check of units:

$$[\sigma/(a\cdot c^2)] = (\mathrm{J\cdot m^{-2}})/(\mathrm{m} \cdot \mathrm{m^2\cdot s^{-2}}) = \mathrm{kg\cdot m^{-3}}$$

The calculation gives $\sqrt{3} \times 4.1\times10^{16} / (2.92\times10^{-5} \times 9\times10^{16}) = 2.70\times10^{4}\ \mathrm{kg\cdot m^{-3}} = 27.0\ \mathrm{g/cm^3}$.

3. The result. Below ρ_max, superpositions are preserved, whatever the material; beyond it, the object is classical. Osmium (22.6 g/cm³) lies just below.

Honesty. This is the same zero of intrinsic decoherence as standard quantum mechanics across the whole accessible range; the boundary ρ_max is the only distinguishing feature, and it is not directly testable — no object reaches ρ_max in an interferometer. The averaging is done over the vacuum cell, not over the volume of a nucleus or of an atom: the threshold is a local property of the arena, not a property of the object.

10.5281/zenodo.22668459

Appendix F — The galactic threshold a_0: rotation curves without dark matter

MOND posits a critical acceleration $a_0 \approx 1.2\times10^{-10}$ m/s² in order to fit the rotation curves. Here a_0 is not posited: it is derived from the framework's single anchor.

1. The single anchor. The framework has one input quantity: the vacuum energy density ρ_Λ. From it comes the closure curvature $k = \rho\_\Lambda/\sigma$ (σ = the tension of the interface) — the residual curvature of the interface closed upon itself.

2. The mechanism. At large distance, the radial and front shares of the tension compensate: mean gravity is rigorously Newtonian. But below a critical acceleration, the cross term of presence intermittency (the interference of the branches at the front) adds a further slope $[2\cdot2\sqrt{f(1-f)}/3]\cdot\sqrt{A}/r$, where f is the presence fraction. At equipartition ($f = 1/2$), $\sqrt{f(1-f)} = 1/2$, and this slope generates an effective threshold.

3. The result:

$$\mathbf{a_0 = (5/48)\cdot c^2\cdot k = 1.203\times10^{-10}\ m/s^2}$$

Check of units: $[c^2\cdot k] = (m^2\cdot s^{-2})(m^{-1}) = m\cdot s^{-2}$ — an acceleration, as required. Compared with the empirical value $1.20(\pm0.02)\times10^{-10}$ m/s²: agreement to 0.3 %, within the measurement uncertainty. The plateau velocity of a galaxy of 10^{11} solar masses follows as 200 km/s — the observed value.

The rare gain. MOND POSITS a_0; nobody derives it. Here it follows from the single anchor ρ_Λ, through k. And the Hubble constant $H_0 = k\cdot c$ proceeds from the SAME k: H_0 and a_0 have a common source, which is a testable statement proper to the framework.

Honesty. The mechanism is a candidate, and galaxies are reproduced; but clusters of galaxies remain in deficit by a factor of two — the classic wall of every law of this kind, which the framework does not dodge.

10.5281/zenodo.22668459

Appendix G — The magnetic moment: g = 2 native

The gyromagnetic factor of the electron is $g \approx 2$. The Standard Model posits it ($g = 2$ for a Dirac spinor); here it follows from the structure of spin.

1. Spin, from the two sides. The spin ½ of the electron is the orientation of the interface: its two sides (the two normals) generate the double cover of SO(3), hence an object with two states — the spin-½ representation.

2. The g. Under a rotation of half a turn in a field, the holonomy of this two-sided object gives exactly the Dirac Landé factor:

$$\mathbf{g = 2}$$

obtained from the geometric orientation, not posited.

The difference is the running. The measured value $g = 2.0023$ differs from 2 by the anomaly $g - 2 = 0.0023$: this is vacuum polarisation, that is, the running (Appendix B). The framework derives the native $g = 2$ and the SENSE of the anomaly; the exact decimals of $g - 2$ (the most precise measurements in science) require the screening coefficient, named as a debt.

10.5281/zenodo.22668459

Appendix H — The spectrum of charges: 0, ±1/3, ±2/3, ±1

The Standard Model observes the fractional charges of the quarks (±1/3, ±2/3) and postulates that quarks carry colour and leptons do not. Here both follow from a single structure.

1. Charge is a phase. Electric charge is carried by the relative phase between the three fields, constrained to the Z_3 centre of su(3) — three values, one per third of a turn:

charge ↔ winding of the relative phase, constrained to Z_3 (three values)

2. The selection rule, derived. An excitation of FRACTIONAL charge must specify its residence (on which field the winding lives): it carries the three-state index, and is therefore a coloured triplet (N_c = 3). An excitation of INTEGER charge is blind to the residence: it is a colourless singlet.

fractional ↔ coloured ; integer ↔ colourless

This is why quarks carry colour and leptons do not — the rule that the Standard Model postulates follows here from the difference between winding the total phase and winding it field by field.

3. The result. The complete spectrum of charges is:

0, ±1/3, ±2/3, ±1 — and nothing else

What is derived, and what is not. The Z_3 centre of su(3) (quantisation in thirds) and the selection rule are derived. The SU(2) and U(1) factors of the complete algebra are not entirely derived — a named debt (the su(2) algebra itself is derived: the debt concerns the complete gauge structure, not the generators).

10.5281/zenodo.22668459

Appendix I — The multiplicities: N_c = 3, N_gen = 3

The Standard Model counts three colours and three generations without deriving them. Here both counts come out of the structure.

1. Three colours. A fractional charge carries a three-state residence index, and its transitions form the three-by-three matrix minus the trace — the eight gluons:

$$N\_c = 3 \quad \rightarrow \quad \text{transitions} = 3\times3 - 1 = 8 \text{ (the gluons)}$$

2. Three generations.

$$N\_gen = 6/2 = 3 \qquad \text{(3 colours} \times \text{2: matter and antimatter)}$$

3. The bookkeeping closes. The sum of squared charges, weighted by colours, closes on the exact number of standard physics:

$$\Sigma\, N\_c\cdot q^2 = 1 + 3\cdot(4/9 + 1/9) = 8/3 \;\; \text{per generation}$$

These three results — N_c = 3, N_gen = 3, and "colourless leptons / coloured quarks" — are derived, not postulated. They feed directly into the running slopes (Appendices B and D).

10.5281/zenodo.22668459

Appendix J — The deflection of light and $\gamma = 1$

A gravity reduced to a scalar field would predict a deflection of light incompatible with observation. The framework escapes this objection, and here is why.

1. What governs the metric. The dynamical variable u (the normal displacement of the interface) is a scalar — but what governs the tensor structure of the metric is not u, it is the EXTRINSIC CURVATURE of Σ, its derivative. The curvature of a surface is tensorial (K_{ab}), and it is this that carries the deflection, the advance of the perihelion and the spectral shift.

2. The result. The post-Newtonian parameter γ, which measures the curvature of space per unit mass, is derived exactly:

$\gamma = 1$ → solar deflection = 1.751 arcseconds

— the value of Eddington and his successors, obtained with no calibration (the mass of the Sun is a measured input, as in any theory; the deflection formula itself is derived).

Traceability note. The second post-Newtonian parameter, $\beta = 1$ (exact, by theorem), together with $\gamma = 1$ place the framework in agreement with every solar-system bound (Cassini, Mercury).

10.5281/zenodo.22668459

Appendix K — The precession of Mercury and the parameter β = 1

The advance of Mercury's perihelion — 43 arcseconds per century unexplained by Newton — was the first triumph of general relativity. The framework recovers it with no parameter, through its own clock rates.

1. The clock rate. The slowing of time in a gravitational potential Φ is given, in the framework, by

$$g_{00} = -e^{(2\Phi/c^2)}$$

This form never vanishes — time slows without stopping (no clock-rate horizon) — and its second-order expansion fixes exactly the post-Newtonian parameter that measures the non-linearity of gravity:

$$\beta = 1 \quad \text{(exact, theorem T8)}$$

2. The result. The composition of clock rates at second order generates the advance of the perihelion:

43.0 arcseconds per century

— the measured value, recovered with no adjustable parameter. Together with γ = 1 (Appendix J), the framework passes the whole set of solar-system tests.

10.5281/zenodo.22668459

Appendix L — The electron shells: 2, 8, 18, 32

The filling numbers of the electron shells — 2, 8, 18, 32 — are one of the fundamental facts of chemistry. Standard quantum physics explains them by the Pauli principle and the quantum numbers, but does not DERIVE them: it observes and codifies them. Here they follow from geometry.

1. Spherical symmetry. Our three spatial dimensions have spherical symmetry — the group SO(3). The degeneracies of its representations, combined with the two-state spin (the two sides, the Pauli principle), give the capacity of each shell:

$$2, 8, 18, 32 \quad (= 2n^2 \text{ for } n = 1, 2, 3, 4)$$

2. What is derived, and what is not. The ELECTRON shells (2, 8, 18, 32) follow from SO(3) symmetry and spin. The NUCLEAR magic numbers (2, 8, 20, 28 …) do NOT coincide with this sequence: the 20 and the 28 require the strong nuclear spin–orbit coupling, whose geometric analogue at the interface is not yet built — a named direction of work, not an achievement.

10.5281/zenodo.22668459

Appendix M — The surface term of nuclear radii: the edge across the three fields

1. The setting. A nucleus of A nucleons at fixed density (derived incompressibility): volume $A \cdot v_0$, $v_0 = (4/3)\pi \cdot a\_nuc^3$, a_nuc = 1.0635 fm (the declared anchor). The edge is not sharp: the density falls over a finite width. For a Fermi profile of half-radius C and diffuseness z, conservation of volume reads $A \cdot v_0 = (4\pi/3) \cdot (C^3 + \pi^2 z^2 C)$, whence, to first order:

$$\mathbf{C(A) = a\_nuc \cdot A^{(1/3)} \cdot [1 - \pi^2 z^2/(3a\_nuc^2 A^{(2/3)})]}$$

The sign (a reduction) and the structure in A (a decreasing correction) are derived; the domain is the liquid-drop regime ($A \gtrsim 20$).

2. The width (S25). The fall spreads over the local cell of the cascade, a_loc = $(\hbar c/\rho\_nuc)^{(1/4)}$ = 1.019 fm (conversion 10–90 → Fermi z: factor 4.394, a declared convention). S25: the three windings spread independently, composition in quadrature:

$$\mathbf{z = \sqrt{3} \cdot a\_loc/4.394 = 0.402\ fm}$$

Correction at A = 60: $\pi^2 z^2/(3a\_nuc^2 \cdot 60^{(2/3)}) = 3.0\ \%$.

3. The judgement, in the right observable. The r_0 of the data is an RMS charge radius; for a Fermi profile, $\langle r^2 \rangle = (3/5)C^2 \cdot [1 + (7/3)(\pi z/C)^2]$, with C(A) at conserved volume, plus the proper size of the proton ($\langle r^2 \rangle\_p = 0.709\ fm^2$) and the charge skin of the neutron ($(N/Z) \cdot \langle r^2 \rangle\_n$, $-0.116\ fm^2$). In this observable, r_0(RMS) decreases with A — as the measurement does.

A free fit, with the target sealed, on two independent sets of charge radii (47 and 65 stable isotopes, from C-12 to U-238) gives z = 0.397 ± 0.017 fm and z = 0.369 fm: both converge on the prediction (0.402) and exclude simple smoothing (0.232) at ten standard deviations.

The judge is robust: a constant shift of $\langle r^2 \rangle$ by 0.1 fm^2 (the order of shell effects) moves z by only 0.013 fm. The residual structure (0.05 fm: magic shells, neutron skin, deformation) is real and of zero mean — it does not bear on the verdict.

A global scale offset ($c_0 \approx 1.15$–1.17 fm against a_nuc = 1.0635 — the charge scale against the matter scale) is named separately and not resolved. It is the same distinction as elsewhere in this document: R_q, the charge radius carried by the doublet, is not R_d, the density radius carried by the singlet.

Method note: a fit that omits the volume reduction in C(A) gives z ≈ 0.31 — that model contradicts incompressibility and must be set aside.

4. Statuses. The form C(A): derived (conservation of volume). The √3 width: derived from S25 (a source statement; the higher stage — deriving S25 from P1 and from residence — is open). Empirical judgement: confirmed on two independent fits (47–65 isotopes, ten standard deviations from simple smoothing). The matter/charge offset: a named debt.

10.5281/zenodo.22668459

Appendix N — The charge radii of the proton and the neutron: the two presence bounds

1. The setting. A nucleon carries three charge windings (Appendix H) distributed between a core and a periphery: the core at the radius of the proton's own cell, $r_c = (4\pi/3)\cdot\hbar c/E_N = 0.880$ fm (fixed by the energy alone); the periphery at the radius of the cell of nuclear saturation, $r_s^0 = 1.019$ fm. The squared charge radius is the sum weighted by the charges:

Proton (uud): $\langle r^2\rangle_p = (4/3)r_c^2 - (1/3)r_s^2$ **Neutron (udd, S24):** $\langle r^2\rangle_n = (2/3)(r_c^2 - r_s^2)$

With no further piece: proton 0.687 fm² (−2.8 %), neutron −0.176 fm² (1.51 times the measurement).

2. The two bounds and the exponent. Charge compensation costs the periphery a fraction f of its energy; at fixed saturation density, volume follows energy: $r_s = r_s^0\cdot(1 - f)^{(1/3)}$. The fraction is fixed by the two presence bounds of the lepton sector ($f_e = 1/16$, the bound of the interface; $f_\mu = ½$, the threshold), resummed over the crossings of the threshold: $f = f_e/(1 - f_\mu^n)$, where n is the number of crossings — dictated by S24 before any number: the neutron's compensation is internal (one side, n = 1, f = 1/8); the proton's is projected across the interface (two sides, n = 2, f = 1/12).

3. The result. Neutron: $r_s = 0.9746$ fm, $\langle r^2\rangle_n = -0.1166$ fm² against −0.1160 measured (+0.5 %). Proton: $r_s = 0.9899$ fm, $\langle r^2\rangle_p = 0.7067$ fm² against 0.7071 (−0.1 %). Cross-check — the exponents swapped: the neutron with n = 2 gives −0.1365 (+17.7 %, it fails); the proton with n = 1 gives +1.4 % (the proton, being a sum, discriminates weakly; the neutron, being a difference, is the precision instrument).

4. Statuses. The radii r_c, r_s^0: native (the proper cell, the saturation cell). The bounds f_e, f_μ: native. The exponent n: derived from S24 (internal/projected). The form $1/(1 - f_\mu^n)$: a resummation — a structure, not a free factor — whose physical object remains to be derived: a named debt. The magnitude of the neutron, an open target of S24, never aimed at — but see the reservation in point 5: it is not an independent judge as long as E_N enters as a measured value. Status: strong candidate.

5. A reservation that must be stated. This calculation uses the MEASURED nucleon energy, $E_N = 938.9$ MeV, in r_c, whereas Section 8 derives $E_N = 964$ MeV from the locus. The two columns: with the measured energy, $\langle r^2\rangle_p = 0.7067$ (−0.1 %) and $\langle r^2\rangle_n = -0.1166$ (+0.5 %); with the derived energy, 0.6534 (−7.6 %) and −0.1433 (+23.5 %). The sensitivity is structural: $\langle r^2\rangle_n$ is the difference of two nearly equal lengths and amplifies any error in the input by a factor of 8.9. It follows that the neutron is not an independent judge of the mechanism as long as the nucleon energy enters it as a measured value — and that the shell length used here has not been harmonised with the cell. This is an open debt, stated in S.2.

10.5281/zenodo.22668459

Appendix O — The weak energy: the median plane of the interface

1. The setting. The thickness of the interface, counted in e-folds of scale between its two anchors:

$$L = \ln(a\_vacuum/a\_nuc) = \ln(29.2\ \mu m / 1.0635\ fm) = 24.04$$

— the tower, the same quantity as in $\alpha^{-1} = 2\pi(L-2)(1-d^2)$. One turn is a step of dilation and is worth 2π e-folds of scale — the dilation–winding identity (a source statement), the same as the leptonic saddle R = 2π. The two sides border this thickness; the median plane lies at L/2 = 12.02 e-folds above the limit object (the electron, outside the interface). The starting object: the electron, at the presence bound (1/16), of energy m_e = 0.511 MeV.

2. The calculation. E_median = m_e·e^(L/2) = 84.7 GeV. Comparison: √(M_W·M_Z) = √(80.369 × 91.188) = 85.61 GeV → −1.1 %. In e-folds: ln(M_W/m_e) = 11.966, ln(M_Z/m_e) = 12.092, L/2 = 12.020 — in the middle. Consistency check: ln(M_Z/M_W) = 0.126 = −ln(cos θ_W) exactly: the Z is the W plus the angle, not one turn more.

Descent through the derived angle (cos θ_W = 0.8815): M_W = E_median·√cos θ_W = 79.6 GeV; M_Z = E_median/√cos θ_W = 90.3 GeV; $g^2 = 4\pi\alpha/\sin^2\theta\_W = 0.4247$; v = 2M_W/g = 244.3 GeV; $G\_F = \sqrt{2}\cdot g^2/(8M\_W^2) = 1.185\times10^{-5}\ GeV^{-2}$.

3. The readings set aside. The whole thickness (24 e-folds): 10^7 GeV, nothing lives there. The count in half-turns of presence from the nucleon: 2.5–7 GeV (the presence counter is not the energy counter). The integer 12 (the twelve rotations of the frame): 83.2 GeV, +3.5 % on the W — a coincidence with L/2; “L = 24 exactly” is excluded by the masses. Starting from the tau, the muon or the nucleon: none falls on a native fraction.

4. Statuses. Inputs: ρ_Λ, ρ_nuc (anchors), m_e (a declared constant), the angle (derived) — no new ones. Readings not derived: “the thickness = the tower L”; “the flip at the median plane” (motivated by the equivalence of the sides — a symmetry gives a centre, not an orientation). Residue −1.1 %, of the order of the uncertainty on a_nuc.

Status: strong candidate. A precision that must be stated: computed in the native chain, that is with the electron mass derived rather than measured, the median plane equals M_F·e^(−12π) = 84.3 GeV, which is 1.5 % below √(M_W·M_Z) = 85.61; the route using the measured electron mass gives 84.7 GeV, so the two agree to 0.4 %; the two exponentials cancel and the result no longer depends on L. The 84.7 GeV quoted above uses the measured electron mass; the two routes therefore agree to 0.4 %, a check of internal consistency the older tower did not give.

10.5281/zenodo.22668459

Appendix P — The valley of stability: what holds the nucleus together

1. The two costs. Bare cores: Z net torsions of +1 (the proton's compensation is projected far away, S24) within a ball $R = a\_nuc \cdot A^{1/3}$, with the derived 1/r potential ($\alpha = 1/137.44$): $E\_c = a\_c \cdot Z^2/A^{1/3}$, $a\_c = (3/5)\cdot\alpha\cdot\hbar c/r_0$. Asymmetry, in two native parts: (i) exclusion — two species on two scales; $k\_F = (3\pi^2\rho/2)^{1/3}$, $E\_F = (\hbar c\cdot k\_F)^2/(2E\_N)$, kinetic share $E\_F/3$; (ii) the p–n crossing at the median plane — a single attempt (the correlated pair holds: an observation), costing $f\_e = 1/16$ of the peripheral shell (333 MeV) = 20.8 MeV.

2. The surface reduction. The cells of the surface layer are engaged by half (S25); what is missing at the surface has the thickness of half a cell. Surface fraction $3\delta/R$:

$$a\_sym(A) = S\_v\cdot(1 - 3\delta/R)$$

Other native thicknesses tested: the edge z = 0.402 fm (S25), the reduced cell $a/\sqrt{3}$ = 0.618 fm, the cell a = 1.0635 fm.

3. The result. At the radius of the equivalent uniform sphere, r_0 = 1.20 fm — a charge radius, R_q, which is what these cost formulas require: a_c = 0.716 MeV (measured 0.71), exclusion 11.1 MeV, S_0 = 31.9 MeV (measured 31.6 ± 2.2), the giant dipole resonance reproduced (+0.0 % on average over Pb, Sn, Zr, Fe). Valley, $N/Z - 1 = a\_c\cdot A^{2/3}/(2\cdot a\_sym(A))$ with $\delta = r_0/\sqrt{3}$: Sn-120 1.369 (observed 1.400), Pb-208 1.509 (1.537), U-238 1.551 (1.587) — rms($A \geq 90$) = 0.039; free fit of δ: 0.74 fm. Light nuclei ($A < 90$): the shell structure (plateaux at the magic N and Z) dominates.

4. Statuses. Structure: derived (two costs, surface in cells, surface reduction by sharing — no force, no posited Coulomb, no liquid drop). a_c, exclusion: derived at the scale r_0. The crossing (20.8): a strong candidate with an independent judge (S_0). On the two radii: r_0 = 1.20 fm is the charge radius, which follows the doublet; the anchor 1.0635 fm is the density radius, which follows the singlet — two distinct extents, not two conventions. The readings "one side out of two" and "packing" are set aside. Three judges close together (a_c, S_0, the resonance); the valley to 2 %.

The pairing coefficient of light nuclei: $W = 3 \times E\_cross$ = 62 MeV — a nucleon without a partner unbalances all three fields (three residences, S26); free fit in continuous Z gives 2.9–3.1 × E_cross; strong candidate. Debts: δ at the scale r_0; the width of the plateaux; the rule of retention by one side.

10.5281/zenodo.22668459

Appendix Q — The three forces: the law of variation, the three lines from the anchors, the force between two colours

1. The structure. The twelve rotations of the frame of the interface decompose into three algebras: u(1) (the phase, 1 generator), su(2) (the two sides, 3), su(3) (the three fields, 8). The static cost is the same for all three at quadratic order: $c_3 = ½$ (T16). The charges: the phase carries the winding number Q; the sides carry $T_3 = ±½$ (side membership, S21); the fields carry the residence (colour).

$$12 = 1 + 3 + 8 \rightarrow u(1) \oplus su(2) \oplus su(3) \quad ; \quad c_3 = ½ \text{ for each}$$

2. The law of variation. The framework has no running coupling: it has a response that saturates, whose decrease with the fineness of the probe is a constant slope per e-fold in 1/α (0.21218 per e-fold and per charged winding — Appendix B). Rule S27: only the sources present at the scale μ respond (a winding of proper energy m counts only for μ > m). Slope: $b_i(\mu) = (11/3)\cdot N_i - (2/3)\cdot\Sigma_{present} T_i$, with N_i the number of elements the structure permutes (three fields, two sides, zero for the phase — equal, by consequence and not by borrowing, to the Casimir C_A of the derived algebra). The 11/3: 12 − 1 = the moment of the carrier minus its orbital response, per element.

Sources: fields — (2/3) per quark present; sides — (2/3)·(½) = ⅓ per left-handed doublet present; phase — below the Z: $(2/3\pi)\cdot Q^2\cdot N_c$ in 1/α; above: $(2/3)(3/5)\cdot Y^2$. Native Higgs: a singlet, 0. Results:

$$b_i(\mu) = (11/3)\cdot N_i - (2/3)\cdot\Sigma_{present} T_i \rightarrow b_3 = 7, \; b_2 = 10/3, \; b_1 = -4$$

The Standard Model, with a Higgs doublet, has 19/6 and −41/10 instead: the difference is a physical one, and it should be confronted with the electroweak precision fits, not with the central value at the Z alone.

3. The three lines from the anchors (no value measured at the Z as input). Phase: 1/α = 137.44 at the vacuum scale, then $-(2/3\pi)\cdot\Sigma\, Q^2\cdot N_c\cdot\ln(\mu/m)$ over e, μ, τ, u, d, s, c, b, t → $1/\alpha(M_Z) = 126.97$ (measured 127.95; −0.8 %). Fields: bare plateau $\alpha_0 = g^2 = 1$ at the locus $\ell_c = a/\sqrt{3}$ (321 MeV), $b_3(N)$ with N = 3, 4, 5, 6 at the masses m_c, m_b, m_t → $\alpha_s(M_Z) = 0.120$ (measured 0.1179; +2 %). Sides: the condition $\sin^2\theta_W = 3/8$ at μ_{12}, slopes b_1, b_2 above the Z, then descent to the Z → $\sin^2\theta_W(M_Z) = 0.229$ with $\mu_{12} = 1.0\times10^{13}$ GeV (measured 0.2312; −1 %).

The two other meeting points, predicted: $1/\alpha_1 = 1/\alpha_3$ at 2.2×10^{14} GeV; $1/\alpha_2 = 1/\alpha_3$ at 7.2×10^{16}; at μ_{12}, $1/\alpha_1 = 1/\alpha_2 = 42.1$ and $1/\alpha_3 = 36.8$ (−12 %).

$$1/\alpha(M_Z) = 126.97 \quad ; \quad \alpha_s(M_Z) = 0.120 \quad ; \quad \sin^2\theta_W(M_Z) = 0.229 \quad \text{(measured 127.95; 0.118; 0.2312)}$$

4. The weak scale. The thickness of the interface in e-folds is the tower $L = \ln(a_{vacuum}/a_{nuc}) = 24.04$; the change of side is paid at the median plane, L/2:

10.5281/zenodo.22668459

$$E\_median = m\_e \cdot e\verb|^|(L/2) = 84.7 \text{ GeV} \quad (\text{judge: } \sqrt{(M\_W \cdot M\_Z)} = 85.61) \quad ; \quad M\_W = 79.6, \; M\_Z = 90.3 \text{ GeV}$$

with $v = 2M\_W/g = 244.3$ GeV and $G\_F = \sqrt{2} \cdot g^2/(8M\_W^2) = 1.185\times10^{-5}$ GeV^{-2} (Appendix O).

5. The force between two colours. Separating two colours displaces two fields relative to one another — the doublet, of rigidity κq^4 with no restoring term at large distance: a linear response, a constant force, with the three fields resisting (N = 3), g = E_N (the whole object, the three windings inseparable), $\ell = a/\sqrt{3}$ and $\kappa = \hbar c/a$. At short distance, a quark is not an object but a residence: the force is the response of the medium to a probe, weighted by the presence of the displaced colour.

$$T = 3\sqrt{3} \cdot E\_N^2/(8\pi\hbar c) = 924 \text{ MeV/fm} \quad ; \quad F(r) = T + (4/3) \cdot \alpha(\hbar c/r) \cdot (½)\verb|^|(2r/\ell\_c) \cdot \hbar c/r^2$$

Against the force measured on the lattice ($F = \sigma + e \cdot \hbar c/r^2$, $e \approx 0.29$), the presence factor reproduces the coefficient from 0.05 to 0.62 fm to 7 % with no parameter — a strong candidate, the form not exclusive within the ± 9 % margin of the target.

6. Statuses and debts. Derived: the structure, the cost ½, the 11/3 per unit, b_3, the slope of the phase below the Z, α, the angle 3/8, the restoring force (a strong candidate, one judge). Source statement: S27 (the scale threshold of the sources). Candidates: the bare plateau at the locus; the weak scale (two readings: the thickness = the tower, the flip at the median); the presence factor; the descent as a countdown of the frame.

7. The electron mass from the anchors. (i) The tension: $\sigma = 4.1\times10^{16}$ J·m^{-2}, an anchor of structure — its value is read off gravity, $\sigma = \sqrt{(c^4\rho\_\Lambda/12\pi G)} = 4.125\times10^{16}$. The second route, through the expansion ($\sigma = \rho\_\Lambda \cdot c/(\sqrt{3} \cdot H_0) = 4.20\times10^{16}$), is not an independent verification: the two coincide only if $\Omega\_\Lambda = 2/3$ exactly, and their difference (2 % here) measures the departure from that value — the same fact as the 2.5σ tension, seen from the other side. It therefore provides no error budget for other results.

(ii) The absolute mass of the anchors: $M\_F = \sigma \cdot \sqrt{(\hbar/(c^3\rho\_\Lambda))} = 1.976\times10^{18}$ GeV — the framework's Planck mass, defined by the emergent law $G = c^4\rho\_\Lambda/(12\pi\sigma^2)$; with G measured, $M\_P/\sqrt{(12\pi)} = 1.988\times10^{18}$ (agreement to 0.6 %). (iii) The bound of the birth (S28): E_median·e^(12π), twelve half-turns of π e-folds above the median plane; the conversion of π e-folds per half-turn is the dilation–winding identity (a source statement; R = 2π at the saddle, judged to 0.27 %); the bound equals M_F to 3 %. (iv) The centre: E_median = m_e·e^(L/2), a reading judged by the weak energy (84.7 GeV against √(M_W·M_Z) = 85.61, −1.1 %).

(v) The mass:

$$m\_e = \sigma \cdot \sqrt{(\hbar/(c^3\rho\_\Lambda))} \cdot e\verb|^|(-12\pi - L/2) = 0.509 \text{ MeV} \quad (\text{measured } 0.511; -0.4\ \%)$$

Sensitivity: $m\_e \propto (\rho\_\Lambda/\rho\_nuc)\verb|^|(1/8)$ — 2 % on ρ_Λ gives 0.25 %; the −0.4 % offset is real, not covered by that margin. Order of operations: the law G, the cascade law, the reading of the median, the map in half-turns (11, 9, 8) and S28 all precede this calculation; G enters through $M\_F = \sqrt{(\hbar c/12\pi G)}$; what is tested is the ratio e^(−12π − L/2) = m_e/M_F. Derived: the cascade

10.5281/zenodo.22668459

law, L, the twelve rotations; emergent: G, R_Σ, T; posited and judged: the conversion of the half-turn, the median at L/2 above the limit object. A consequence at 0.4 % from three properties of the fields, a strong candidate; it bypasses the theorem of the bounded scale from above.

10.5281/zenodo.22668459

Appendix R — Glossary of symbols

Every symbol of the framework: its name, what it means physically, its units, and the usual equivalent a reader may recognise. No notation is used in this document without appearing here.

Symbol	What it is	Units	Usual equivalent / landmark
Σ	The interface: the common wall where the three fields meet. Everything we observe is an excitation of it.	—	Space-time itself, in this framework
σ	The tension of the interface: the energy it costs to increase its area. The single fundamental quantity of the framework.	$J \cdot m^{-2}$	≈ 4.1×10^{16} $J \cdot m^{-2}$; no direct equivalent
κ	The curvature rigidity: the energy cost of bending the interface without stretching it.	J	Sets the cell scale, a = √(κ/σ)
ρ_Λ	The vacuum energy density: the framework's single dimensional anchor, measured and declared.	$J \cdot m^{-3}$	The cosmological constant, ≈ 5.3×10^{-10} $J \cdot m^{-3}$
k	The closure curvature, k = ρ_Λ/σ: the residual curvature of the interface closed upon itself.	m^{-1}	Carries H_0 and a_0 alike
R_Σ	The closure radius, R_Σ = 3σ/ρ_Λ: the extent at which the interface closes.	m	≈ 2.3×10^{26} m = 1.73 Hubble radii
a	The cell: the resolution scale of the medium. Nothing is distinguished below it.	m	29.2 µm in the vacuum; 1.0635 fm at nuclear density
a_nuc	The cell of matter at the ceiling: fixed from within, by requiring the cascade and the content to agree.	fm	1.0635 fm; the anchor of the nuclear sector
ℓ_c	The locus, ℓ_c = a/√3: the length at which tension and rigidity cross over.	fm	0.61 fm; the confinement locus
L	The tower: the interval in scale between the two anchors, L = ln(a_vacuum/a_nuc).	e-folds	24.04; carries α and the weak scale
R_d	The density radius: the extent of what weighs, carried by the singlet. It counts the nucleons and enters every volume formula.	fm	1.1427·A^(1/3) fm for a nucleus
R_q	The charge radius: the extent of what carries charge, carried by the	fm	≈ 1.20·A^(1/3) fm. R_q > R_d: their difference is the neutron skin

10.5281/zenodo.22668459

	doublet. It is what electron scattering and spectroscopy measure.		
n_0	The saturation density: the number of nucleons per volume in nuclear matter. A count, with no mass — the only measured input of the sector.	fm^{-3}	0.16 nucleons/fm^3
f	The presence fraction: the share of turns during which an object is on Σ. A frequency, never a duration.	—	1 for the nucleon, ½ for the muon, 1/16 for the electron
d	The angle of the generation circle: the zero-point fluctuation of the mass sector.	radians	4.9°; enters α as $(1 - d^2)$
T	The tension operator: Hermitian, with a real discrete spectrum, $\langle T \rangle = 0$ at rest.	—	Its redistribution direction is what time emerges as
c_a	The proper speed of the interface, $c/\sqrt{3}$: a wave in Σ drags all three fields.	$m \cdot s^{-1}$	≈ 58 % of c
ρ_{max}	The saturation boundary, $\sqrt{3}\sigma/(a\, c^2)$: the density at which phase coherence ceases, averaged over the vacuum cell.	$g \cdot cm^{-3}$	27.0 g/cm^3; osmium is 22.6
a_0	The galactic acceleration threshold, $(5/48) \cdot c^2 k$.	$m \cdot s^{-2}$	1.203×10^{-10} m/s^2; MOND's empirical constant
E_N	The energy of the nucleon: three residences, each at the energy of the locus.	MeV	964 MeV derived; 938.9 measured
M_F	The absolute mass of the anchors, $\sigma \cdot \sqrt{\hbar/(c^3 \rho_\Lambda)}$.	GeV	1.98×10^{18} GeV = the Planck mass divided by $\sqrt{12\pi}$

10.5281/zenodo.22668459

Appendix S — What a reader alone must be able to check

This appendix gathers the definitions, the inputs and the weak points that the body of the text takes as known. It is written so that this document can be read without the framework document.

S.1 — The tower L, a single definition. $L = \ln(a\_vacuum/a\_nuc)$, a ratio of two lengths, not of two densities. a_nuc = 1.0635 fm is the cell of matter at the ceiling. It is not read off outside: it is fixed from within, by requiring the two laws of the framework to agree at nuclear density — the cascade, $\rho = \hbar c/a^4$, and the content, $\rho = n_0 \cdot E\_N$ with $E\_N = 3\sqrt{3}\cdot\hbar c/a$. These two expressions agree for one value of a only, and that condition IS the definition of the cell:

$$\hbar c/a^4 = n_0\cdot 3\sqrt{3}\cdot\hbar c/a \quad\Leftrightarrow\quad a^3 = 1/(3\sqrt{3}\cdot n_0) \quad\Longrightarrow\quad a\_nuc = 1.0635\ \text{fm}$$

This is not a numerical verification but an internal condition whose only measured input is n_0 = 0.16 nucleons/fm³, a count per volume with no mass. Measured densities and masses are therefore not inputs but judges. $a\_vacuum = \sqrt{\kappa/\sigma}$ = 29.2 µm is the cell of the vacuum; the bare cascade would give $(\hbar c/\rho\_\Lambda)^{(1/4)}$ = 87.9 µm, and the factor of three between the two is not explained — see the two points below.

$$L = \ln(29.2\ \mu\text{m} / 1.0635\ \text{fm}) = 24.036$$

This is the only definition used in this document; every line that uses L — the fine-structure constant, the median plane, the electron mass — is computed with it.

Two points about L, stated frankly. First, the dilute bound admits two readings — the cell of a single field taken alone (29.2 µm, used here) and the cascade floor (87.9 µm). The choice between them is not derived: it is made by consistency of use, the counted cell being the one that serves everywhere else in the framework — it is the one that gives 16.9 µm, the scale of the collective mode, which carries the short gravitational range, the density threshold and the minimum mass of a black hole — whereas the cascade floor is used as a cell nowhere.

The factor of three between the two is not explained; attributing it to the counting of zero-point fluctuations does not suffice — a factor of three in length is a factor of eighty-one in density, whereas one half per mode over three modes gives only three halves.

And what this choice commands must be quantified: with the cascade floor, L = 25.14, the fine-structure constant becomes 144.3 (+5.3 %) and the electron mass 0.293 MeV, that is −43 %. The strongest line of this document therefore rests on a choice the document declares not derived. This is the framework's dominant debt, and the reader must be able to weigh it.

S.2 — The charge radii: the two columns. The calculation uses two lengths: the proper cell $r\_c = (4\pi/3)\cdot\hbar c/E\_N$, and a shell length built on the cascade cell at nuclear density (1.019 fm). It is done with E_N measured, not with E_N derived in 8.3. With E_N = 938.9 MeV (measured): $\langle r^2\rangle\_p$ = 0.7067 fm² (−0.1 %) and $\langle r^2\rangle\_n$ = −0.1166 fm² (+0.5 %). With E_N = 964.1 MeV (derived):

10.5281/zenodo.22668459

0.6534 (−7.6 %) and −0.1433 (+23.5 %). The sensitivity is structural: $\langle r^2 \rangle_n$ is the difference of two nearly equal lengths and amplifies any input error by a factor of 8.9. The neutron is therefore not an independent judge of the mechanism as long as the nucleon energy enters it as a measured value.

S.2bis — Two radii, two modes, and a consequence tested. Since density lives on the singlet and charge on the doublet, an object has two extents and one must always say which. R_d is the density radius — what counts the nucleons, $1.1427 \cdot A^{1/3}$ fm for a nucleus; R_q is the charge radius — what electron scattering and spectroscopy measure, $\approx 1.20 \cdot A^{1/3}$ fm. A radius named without qualification in this document is a density radius. The cost formulas of the nuclear sector (Coulomb, exclusion, crossing) are uniform-sphere formulas describing a distribution of charges: they take R_q. The formulas of volume and counting take R_d.

In a nucleus this difference becomes observable, because only the protons carry charge while density counts every nucleon. The framework predicts, with no parameter: the density radius exceeds the charge radius in proportion to the neutron excess $(N - Z)/A$, and the difference vanishes exactly at $N = Z$. On six measured nuclei the correlation is 0.914 and calcium-40, at $N = Z$, gives a skin consistent with zero.

The control that distinguishes the framework, however, is not the correlation — a skin proportional to $(N - Z)/A$ vanishing at $N = Z$ is also the liquid-drop result. It is this: fitted on the symmetric nuclei alone (C-12, O-16, Ca-40), the surface term extrapolates to 1.146 fm, within 0.3 % of the counting radius the density requires (1.1427) — a value that was not aimed at.

S.3 — The density threshold: over what scale it is averaged. The threshold $\rho_{max} = \sqrt{3} \cdot \sigma/(a \cdot c^2) = 27\ g \cdot cm^{-3}$ is not a local density of matter: it is the energy density that saturates a cell of the vacuum. The averaging is therefore done over the vacuum cell (29.2 µm; 16.9 µm for the collective mode), not over the volume of a nucleus or of an atom. This is why a nucleus, whose local density exceeds the threshold by thirteen orders, is not concerned. An open question remains: the cascade makes a vary with the local density, so the threshold moves with its own argument — why the vacuum cell rather than the local cell is not written.

S.4 — The galactic sector: where its two coefficients come from. These carry the flagship prediction, and they must not remain a cross-reference: here is their full derivation.

The threshold. The radius at which the gradient of the metric perturbation crosses the curvature of the background — the crossing radius — is written with the object's quantities alone, its energy E and the tension σ, where $A = E/(12\pi\sigma)$ is the shape constant of the source's proper field:

$$r_t = \sqrt{2A} = \sqrt{E/(6\pi\sigma)}$$

Above this radius the gradient of the perturbation varies fast against the background curvature: the background stays invisible and the dynamics is Newtonian. Below, the perturbation varies more slowly than the background curves, and the expansion around a flat background loses its

10.5281/zenodo.22668459

meaning — this is where the dynamics deviates. Since E grows with the mass, the threshold grows as $\sqrt{M}$: it is not universal, and the position of the step shifts from one system to another.

The acceleration at that radius no longer depends on the source. Evaluating the Newtonian value there, the mass cancels against the energy:

$$\mathbf{a(r\_t) = GM/r\_t^2 = 6\pi\sigma \cdot GM/E = 6\pi G\sigma/c^2 = c^2k/2 = 5.77\times10^{-10}\ m\cdot s^{-2}}$$

This is the unique scale at which the transition operates, whatever the mass — and it can also be written $\sqrt{3\pi G\rho\_\Lambda}$. Since the tension that fixes it is inherited from the vacuum energy density, and not from an acceleration scale, its coincidence with the threshold at which analyses place the onset of the anomaly is a consequence of the cosmological value of ρ_Λ, not a calibration.

The coefficient 0.323. Below the threshold, the chain — amplitude interference, scale tensions, shape equation — gives an additional slope whose prefactor is (2)·(2/3) = 4/3: the factor two from the interference of the two amplitudes, the two thirds from the shape equation (the missing third in spherical geometry). No parameter enters. With the presence fraction f = 1/16:

$$\mathbf{g\_obs/g\_N = 1 + (4/3)\cdot\sqrt{f(1-f)}/\sqrt{x} = 1 + 0.323/\sqrt{x} \qquad where\ x = g\_N/(c^2k)}$$

The coefficient 5/48. It is not a second number: it is the square of the first. Writing the additional term as an acceleration, $(4/3)\cdot\sqrt{f(1-f)}\cdot g\_N/\sqrt{x} = (4/3)\cdot\sqrt{f(1-f)}\cdot\sqrt{c^2k\cdot g\_N}$, one recognises the form $\sqrt{a_0\cdot g\_N}$ with

$$\mathbf{a_0 = [(4/3)\cdot\sqrt{f(1-f)}]^2\cdot c^2k = (16/9)\cdot(1/16)\cdot(15/16)\cdot c^2k = 5/48\cdot c^2k = 1.203\times10^{-10}\ m\cdot s^{-2}}$$

The identity $(4/3)^2\cdot f(1-f) = 5/48$ is exact, not approximate. The galactic threshold is therefore the square of the slope coefficient: a single structural ingredient, the presence fraction, fixes both. Against the empirical value $1.20(\pm0.02)\times10^{-10}$ m·s^{-2}, the agreement is 0.3 %, within the measurement uncertainty; and the plateau velocity of a galaxy of 10^{11} solar masses follows as 200 km/s.

Three accelerations, not to be confused. All three descend from the same curvature $k = \rho\_\Lambda/\sigma$: the front acceleration, $12\pi G\sigma/c^2$, which equals c^2k exactly; the acceleration at the crossing radius, its half; and the galactic threshold, $(5/48)\cdot c^2k$. Their ratios are native — the front is twice the crossing threshold and 9.6 times the galactic one, that 9.6 being 48/5, the inverse square of the prefactor.

S.5 — The fine-structure constant, factor by factor. The formula is $\alpha^{-1} = 2\pi(L-2)(1-d^2)$, and each factor now has its status. The leading 2π is derived. The dilute bound of the path is grounded: the interaction photon is bounded by the coherence threshold, not by the more dilute density floor. The subtraction of two e-folds is derived: an electromagnetic interaction has two ends — a photon emitted at one, absorbed at the other — and each end weights the path by the force it exerts, in $1/r^2$. On a scale axis, where $s = \ln(r/a)$ and $dr = r\cdot ds$, that weight becomes e^{-s} per e-fold, whose centre of gravity is $\int s\cdot e^{-s}ds / \int e^{-s}ds = 1$ exactly. Each vertex therefore removes one e-fold, and there are two. The control: with the naive measure the weight would

10.5281/zenodo.22668459

decay twice as fast, the subtraction would be one e-fold, and the constant would be 143.7 — excluded by five per cent.

There remains the angle d = 4.9°, the zero-point fluctuation — and its status has changed too. The framework conjectures that this fluctuation belongs to the family of the constant itself: $d^2 = \alpha/(1 - 2\alpha)$. Against the value the lepton sector requires, the bare constant fails by 1.5 % and this self-corrected form falls within 0.06 %. Under the conjecture the angle ceases to be an input: the two-equation system closes on itself and admits a single solution with no parameter — α^{-1} = 137.434 and d = 4.92°, against 137.036 and 4.9° observed. The conjecture is not proved: the debt is displaced, not removed. And the residue of +0.3 % does not move.

S.6 — The mixing angle: what the 3/8 assumes. The value 3/8 at birth is the ratio of traces $Tr(T_3^2)/Tr(Q^2)$ computed on the charge content of one complete generation — the assignment of the fermions into doublets and their hypercharges. The framework derives the structure, but that content per generation is what particle physics has established: the formula is not "from the structure of the charges alone". And the descent from 3/8 to the angle measured at the Z starts from a scale $\mu_{12} \approx 10^{13}$ GeV read off that angle: the value at the Z is a consistency check, not a prediction.

S.7 — The variation slopes and the Higgs. The framework's content differs from the Standard Model on one point: its Higgs mode is a real singlet, not a doublet coupled to the gauge fields. Hence $b_2 = 10/3$ and $b_1 = -4$, against 19/6 and −41/10. This is a physical difference, and it must be confronted with the electroweak precision fits, not with the central value at the Z alone.

S.8 — The strong coupling at the Z. The value 0.120 is obtained by fixing the plateau at the locus ℓ_c, that is, by drawing the strong scale from the second anchor. The 2 % difference from the quoted value is of the order of the difference between definitions of the coupling, but this sentence is a reading, not a derivation.

S.9 — The photon as a state of the doublet. The carrier is here quadratic in the doublet. What this document does not treat: the statistics of such a state, the exact vanishing of its mass beyond quadratic order, and the Lorentz invariance of the full spectrum.

S.10 — Black holes: two statements not to be confused. The framework holds that there is no horizon in the sense of a surface of infinite spectral shift — g_{00} does not vanish in the field — and that the tension saturates rather than diverging. The minimum mass, M_min = a_min·c²/2G, is not defined by a horizon: it is the mass whose gravitational scale reaches the floor a_min = 16.9 µm. That the formula has the form of the Schwarzschild radius is not accidental — G is derived from the same set of constants — but it does not reintroduce a trapping surface.

S.11 — Primordial helium: what is claimed and what is not. The presence 1/8 is used there as a frequency of realisation — the share of nucleons born as neutrons. The same value appears elsewhere as a resummation cost in the charge-radius calculation; the identity of the two roles is not demonstrated, and nothing here rests on it: the judge of helium is a single one, Y_p. The framework says nothing about the abundance of deuterium, which depends on the number of windings — a measured content, not a derived one — nor about lithium.

10.5281/zenodo.22668459

S.12 — CP violation. The chirality mechanism fixes one hand for the leptons of matter and the opposite hand on the other side, and concludes that C and P are each reversed while CP would be preserved. That statement concerns a single object — one screw, one lepton, no mixing — and at that level no phase exists. CP violation lives elsewhere: in the mixing of the three residences. The counting is immediate: a mixing among n states carries $(n - 1)(n - 2)/2$ irreducible physical phases — zero for one or two, exactly one for three. The framework having three fields, hence three residences and three generations, it predicts that a CP-violating phase exists and that it is unique: this is the structure measured since 1964 (kaons) and 2001 (B mesons).

What this counting assumes, as the 3/8 does in S.6: a unitary mixing matrix among three states and non-degenerate masses — both established by particle physics, not derived here. The mathematics of mixing gives one thing more: for three states the mixing invariant is bounded by $1/(6\sqrt{3}) = 0.0962$. The measured value, 3.08×10^{-5}, is three ten-thousandths of that: the observed violation is far from its maximum, and this smallness lies not in the phase — which is of order one — but in the mixing angles, that is, in the overlap of the three residences. That overlap is a content, not a structure: like the number of windings, it is measured and not derived.

S.13 — Statuses, made clear. The closure radius $R_\Sigma = 3\sigma/\rho_\Lambda$ is not derived: it is computed from two anchors and has no named observational counterpart — the framework gains a relation between three quantities, not a prediction. The electron mass is a consequence of the anchors (0.509 MeV, −0.4 %). And the economy of the framework is read in Table 1.3: not two numbers against nineteen, but three anchors and a handful of named inputs, each traced to the result it carries.

S.14 — What the harmonised cell gives, and what it costs. With $a_{nuc} = 1.0635$ fm: L = 24.036; $\alpha^{-1} = 137.44$ (measured 137.036: +0.3 %); the electron mass 0.509 MeV (measured 0.511: −0.4 %), obtained with no measured mass anywhere in the chain; the nucleon energy 964 MeV (measured 939: +2.7 %); the nuclear density 154.3 MeV/fm³ (measured 150.2: +2.7 %); the radius of helium-4 1.688 fm (measured 1.678: +0.6 %). The external judges all fall on the same side and at the same order — a single offset, +2.7 %, wherever the cell enters.

The median plane, a precision that matters. In the native chain the median equals $M_F \cdot e^{(-12\pi)}$ = 84.3 GeV and does not depend on the tower: the two exponentials cancel. The judge is $\sqrt{M_W \cdot M_Z}$ = 85.61 GeV, an offset of −1.5 %. The route that uses the measured electron mass gives 84.7 GeV: the two agree to 0.4 %, a check of internal consistency that the older tower did not provide. Finally, the cell inherits the status of the result that fixes it — the nucleon energy as three residences at the locus, a strong candidate: if that result fell, the cell would fall with it.

10.5281/zenodo.22668459