

Observer-conditioned complexity minimisation selects the Standard Model with right-handed neutrinos: and localises the boundary between law and address

Robin Genis, independent researcher, Haarlem, the Netherlands · roboburr@gmail.com

Preprint, version 2, 18 August 2026 (version 1: 13 August 2026, DOI 10.5281/zenodo.21908485) · canonical living version: ee.robingenis.com/artikel · prediction register: ee.robingenis.com/toetsing

Abstract

We perform an exhaustive, pre-registered search over the Wedderburn-classified finite real spectral triples of noncommutative geometry, ranking candidates by frozen prefix-free description-length measures. Bare complexity minimization fails to select the Standard Model: the minimal admissible geometries yield the wrong unbroken gauge group under all three frozen measures. Adding frozen observer conditions (a light uncoloured charged fermion must exist; charged nuclei; reachability of $SU(3) \times U(1)_{em}$), the search uniquely reconstructs the one-generation Standard Model on $C \oplus H \oplus M_3(C)$, with the hypercharges solved from the anomaly conditions. A cheaper Pati-Salam class initially wins, but a theorem from the exact first-order condition forces quark-lepton Yukawa equality in every embedded-lepton diagram; the measured bottom-tau ratio then eliminates the entire class, including its $SU(5)$ extension. With neutrino mass as a second data gate, the unique survivor is the Standard Model with right-handed neutrinos. Three pre-registered attempts to derive the fine-structure constant fail quantitatively, locating the boundary between derivable structure and environmental parameters; the generation number resists derivation at a quantified price of 10 bits. Predictions: Majorana neutrinos, normal mass ordering (95-99.9%), mass sum near 0.06 eV, $m_{\beta\beta}$ of order 1-10 meV, no new coupled particles, and, under a Bayesian accounting with the universal prior, a θ -solving axion-like sector. All criteria were frozen before computation; all failures are reported.

1. Introduction

The finite geometry F of the spectral action approach (Connes-Chamseddine) has always been an input: the algebra $C \oplus H \oplus M_3(C)$ is chosen because it yields the Standard Model. This paper asks whether F can instead be selected, and by what. Our method is deliberately austere: a frozen, prefix-free description-length measure on the classified space of finite real spectral triples; hard admissibility conditions (chirality, anomaly freedom) that are membership requirements rather than penalties; observer conditions frozen before any scan; and measured low-energy data as final referee. Every criterion in this paper was written down and frozen before the corresponding computation was run, and we report the outcomes that went against us with the same prominence as those that did not. Three of our own derivation attempts are falsified below; the selection result survives them.

1.1 RELATED WORK

The algebra $C \oplus H \oplus M_3(C)$ and its Standard Model realization go back to Connes and Chamseddine; Krajewski classified the finite triples; the Pati-Salam extension was developed by Chamseddine, Connes and van Suijlekom, who found the first-order condition obstructs it on the standard fermion space (our Theorem S' shows why, and how the minimal diagram evades their obstruction structurally). Description-

length selection descends from Solomonoff's universal prior and MDL; observer conditioning has anthropic antecedents (Weinberg; Tegmark), from which this work differs by freezing gates before computation and by using measured low-energy data as exclusion criteria rather than post-hoc accommodation.

1.2 ROBUSTNESS OF THE MEASURES

Three complexity measures (prefix-free algebra coding, real dimension, gauge-group dimension) are carried in parallel; a selection claim is made only when all three agree, and only ordinal comparisons are ever used. Reformulation-dependence is handled as in algorithmic information theory: description length is defined up to the additive constant of the invariance theorem, which cancels in the chain comparisons used here.

2. Search space and frozen measures

Finite real spectral triples with A_F a direct sum of matrix algebras $M_n(K)$, $K \in \{R, C, H\}$ (Wedderburn), Hilbert space and Dirac operator encoded by Krajewski diagrams, KO-dimension 6. Declared universe: up to three summands, $n \leq 4$ (extended to $n \leq 5$ and analytically to four summands in Sec. 8). Complexity of a candidate $F = (\text{algebra}, \text{diagram})$:

$$\begin{aligned} K_F &= K_A + K_{\text{diag}} \\ K_A &= \text{cost}(s) + \sum \text{ over summands } [\text{cost}(n) + \log_2(3)] \\ K_{\text{diag}} &= \text{cost}(r) + r \cdot \log_2(B) + \sum \text{ over blocks } \text{cost}(m) \\ \text{cost}(n) &= 1 + 2 \cdot \text{floor}(\log_2 n) \quad (\text{Elias-gamma, prefix-free}) \end{aligned}$$

with s the number of summands, r the number of block types, B the available block types of the algebra, m block multiplicities. Prefix-free lengths add under composition, so K qualifies as a resistance functional in the sense of the underlying selection framework (Appendix A); the weight per bit is $\ln 2$ (universal prior).

3. Admissibility and calibrations

Admissible diagrams are chiral on the physical representation content (after solving for the anomaly-free $U(1)$ direction, with pseudoreal/real equivalences) and free of all anomalies: cubic $SU(n \geq 3)$, mixed factor²- Y , Y^3 , unimodularity, and the Witten condition for every $Sp/SU(2)$ -like factor.

Calibrations (all passed, all mandatory): the one-generation Standard Model content passes with all anomalies vanishing and even doublet count; leptons-only fails on exactly Y^3 , $SU(2)^2$ - Y and Witten; and the search, run on $C \oplus H \oplus M_3(C)$, must rediscover the SM diagram with the correct hypercharge ratios solved from the anomaly system. An earlier version of the filter failed the third calibration through three identifiable bugs (chirality tested on block indices rather than physical content; Witten applied only to quaternionic summands; the calibration itself not enforced); we document this because the audit trail is part of the method.

4. Bare minimization fails

Of the 54 algebras with $K_A \leq K_A(C \oplus H \oplus M_3(C)) = 12.75$ passing the admissibility gates, the K_F -minimal survivors are, in order: $H \oplus H \oplus M_3(C)$ ($K_F = 28.1$, a left-right quark sector with no $U(1)$ at the

unification scale), $C \oplus C \oplus M_2(C)$ (28.8, no colour), and only then diagrams on the SM algebra, whose own minimal diagram is a $Y = 0$ variant rather than the SM (the true SM content sits at $K_F = 42.3$). A breaking analysis under maximally generous rules (the scalar sector bounded above by the one-index rule, generic vevs) shows none of the K-minimal candidates can reach $SU(3) \times U(1)_{em}$: the failure criterion F1*, frozen at the start, fires unanimously under all three measures. Bare complexity does not select the Standard Model.

5. Observer conditions and uniqueness

We then freeze three observer conditions: (O1a) a chirally protected, uncoloured, charged fermion state must exist (an electron; without it there is no atomic scale separate from the nuclear scale and no chemistry); (O1b) a chirally protected coloured charged state (charged nuclei); (O1c) $SU(3) \times U(1)_{em}$ reachable under the frozen breaking rules. Result: of the ten surviving algebras, nine admit no observer-compatible diagram at all; the bottleneck, in every single case, is the electron. The tenth is $C \oplus H \oplus M_3(C)$, and its minimal observer-compatible diagram is block-for-block the one-generation Standard Model, with hypercharges emerging from the anomaly system. Within the declared universe the SM content is not merely minimal but unique.

6. The embedding flank and Theorem S'

Unification-type algebras with an $M_4(C)$ summand evade the electron gate: after $SU(4)$ breaking, the fundamental splits as $4 \rightarrow 3 + 1$ and the singlet component is a charged lepton. Under frozen breaking amendments (Pati-Salam pattern), 24 such candidates beat the SM content, the cheapest being $H \oplus H \oplus M_4(C)$ at $K_F = 30.3$, whose diagram is exactly the Pati-Salam fermion content plus a neutral block that supplies the $SU(4)$ -breaking scalar. The exact first-order condition $[[D,a],b^\circ] = 0$, imposed component-by-component (numerically exact, by rank computation), admits precisely the required scalar sector: the Majorana block (dim 7), the breaker $(2_L, 4)$ (dim 8), the bidoublet (dim 4), and nothing with no shared index. Notably this diagram evades the classical obstruction that forced the literature's spectral Pati-Salam model to abandon the first-order condition: its neutral sector sits in its own block outside $SU(4)$.

THEOREM S'

Let (A, H, D, J, γ) be an admissible finite triple in which every charged uncoloured fermion state arises as the singlet component of the branching $n \rightarrow (n-1) + 1$ of a fundamental representation of a simple summand $M_n(C)$, $n \geq 4$. Then for every Dirac component allowed by the first-order condition $[[D,a],b^\circ] = 0$, the induced Yukawa coupling is proportional to the identity on the $M_n(C)$ index, and consequently the down-type quark and charged-lepton Yukawa matrices coincide at the breaking scale of that summand.

Proof. Writing the fermion blocks as rectangular matrix spaces with left action by the row summand and J -induced right action by the column summand, the first-order condition applied with independent algebra elements on either side forces every component connecting blocks that share no index to vanish, and every component connecting blocks sharing one index to be a module map for that index, i.e. of the form $\varphi \otimes$ identity on the shared factor. A mass component for the block containing the embedded lepton necessarily shares its $M_n(C)$ index with the quark components of the same block; being the identity on that index, it assigns equal couplings to the colour components (quarks) and the singlet component (lepton). ■ The component spaces were additionally computed numerically-exactly (SVD rank over all 1600 algebra basis pairs), reproducing precisely the module-map dimensions and nothing else.

7. Couplings, and elimination by data

The Pati-Salam candidate passes a two-scale coupling consistency test ($g_4 = g_L = g_R$ at Λ ; SM two-loop below the intermediate scale; matching $\alpha_Y^{-1} = \alpha_R^{-1} + (2/3)\alpha_4^{-1}$): an exact triple crossing exists at $M_{PS} = 3.7 \times 10^{13}$ GeV, $\Lambda = 1.3 \times 10^{15}$ GeV, $\alpha_U^{-1} = 44.5$, with M_{PS} inside the pre-declared seesaw window. But Theorem S' bites: running the measured Yukawas up gives $y_b/y_\tau = 0.65$ at M_{PS} (two-loop QCD), a 35% violation of the forced equality, outside the frozen 25% band. Realistic threshold corrections cannot bridge it: finite matching contributions scale as $(\text{coupling}^2/16\pi^2)$ times short logarithms (the M_R -to- M_{PS} window spans only 1.2 e-folds), giving a declared estimate below 3%, and the diagram's own breaker-induced mixing works in the wrong direction. We register explicitly the escape branch: a demonstrated threshold correction above 13% from a concrete spectrum would reinstate the Pati-Salam candidate; producing one is an open challenge to the reader, not an option we can exclude by fiat. A sweep confirms every observer-compatible diagram in the $M_4(C)$ flank (and the $M_5(C)/SU(5)$ flank, 136 algebras, where gauge-mediated proton decay additionally applies) has embedded leptons, and a search for hybrid diagrams with separate leptons returns empty. The entire embedding class is eliminated by the measured bottom and tau masses.

8. The endgame

The bare SM content has no room for neutrino mass and is excluded by oscillation data. The unique geometry passing all gates: admissibility, observer conditions, b- τ , neutrino mass, is the Standard Model with right-handed neutrinos ($K_F = 47.2$). Robustness: extending the universe to $n = 5$ adds nothing (all 25 O-survivors have embedded leptons and fall under S'; the hybrid escape is empty), and four-summand algebras are excluded by an analytic cost bound ($K_F \geq 52.3$ for any separate-lepton diagram).

Multiplicities. With a baryogenesis gate (CP violation via either the CKM route, requiring three generations, or leptogenesis, requiring two right-handed neutrinos; phase counting $N(n_R - 1)$, calibrated on known cases), the K-minimal observer-compatible multiplicity is one generation plus two ν_R : the measured three-generation world costs exactly 10 bits more ($2^{-10} = 1/1024$). The generation number is thereby an environmental ("address") fact with a quantified price, not a derived one; any future explanation must supply exactly those 10 bits. We verify that the dynamical term of the selection functional cannot: its naive vacuum reading would charge $\sim 10^{228}$ bits per generation and is refuted by our own existence; renormalized, it is flat across candidates.

8B. THE COMBINED ACCOUNTING IS BAYESIAN MODEL COMPARISON

The observer-conditioned measure factorizes per member into discrete structure F (weight $2^{-K(F)}$) and continuous parameters with conditional density. For observed data, total surprise decomposes additively: $-\log_2 P = K(F) + [-\log_2 P(\text{data-window} | F)]$. Model comparison at fixed data must therefore use the sum: K is the prior, typicality the likelihood, and bare K-minimization is the special case of equal likelihoods. All accounting in Secs. 8-10 is this posterior comparison; an earlier prior-only registration of the dark-sector question, and its correction by the posterior analysis, are documented in the working records as a methods note.

9. What is not derivable: three falsifications

Pre-registered and failed: (i) the unification route (SM content plus spectral boundary condition $5g_1^2 = 3g_2^2 = 3g_3^2$, two-loop): predicted $\alpha^{-1}(m_e) = 152.2$ vs 137.04 measured, 11% outside the frozen $\sim 10\%$ criterion; (ii) the bare selection route (Sec. 4); (iii) a parameter-free cutoff-function route ($f(x) = e^{-x}$ forced by the framework's own weight, $f_0 = 1$): predicted $\alpha_U^{-1} \in [1.3, 5.1]$ vs a required 46: a factor 9. The pattern across all computations: countable structure (charges, ratios, mixing angle $3/8$, group content) is derivable; continuous strengths are not. Typicality is then the correct question: within the literature habitability window ($\alpha^{-1} \in [59, 685]$) the measured value sits at log-position 0.34, comfortably interior. The residual "surprise ledger" of the framework: $\alpha \sim 5$ bits (conditioning), generations 10 bits, cosmological constant 3.5-9 bits (band over both literature windows): 18-25 bits in total.

Root diagnosis and meta-stake (added 12 August). The three falsifications share one root with a fourth miss outside this paper (a Zipf demonstration): each time the selection measure, which weighs a-locally over structures, was put in a local chair: as boundary condition, as cutoff function, or as empirical law inside a single member. Formally: K counts bits, so e^{-K} ranks countable alternatives, but singling out a point from a continuum costs infinitely many bits; continuous strengths are therefore address. Because this boundary was formulated after the falsifications, we register it as a frozen meta-stake itself: no first-principles derivation of a dimensionless continuous constant of nature from pure structure selection will ever succeed, by anyone. A parameter-free derivation of α (or another continuous constant) accepted by the community falsifies this paper's address reading. Reductions to other continuous constants, or frameworks introducing new continuous parameters, do not count as counterexamples.

Delegation stake (added 12 August, night). The level distinction points to one deriver that is not the measure: local fixed-point dynamics (asymptotic safety), which runs on exactly the structure selected here (Standard Model up to the Planck scale, no unification) and carries one pre-registration trophy (the 126 GeV Higgs mass, predicted in 2009). Registered as a weak stake: local self-consistency *bounds* continuous address coordinates rather than fixing them. For α the SM-only upper bound on the abelian coupling (Eichhorn-Versteegen) translates to $\alpha^{-1} \gtrsim 75$ -90, shrinking the habitability window from below: a gain of 0.15-0.27 bits in the ledger above. The strong form (unique fixing) is empirically dead for SM-only (the interacting fixed point would put $\alpha \sim 35\%$ too high) and closed via a GUT by Theorem S'. Delegation stake and meta-stake cover each other's flanks: exactly one can win.

10. Predictions

1. Neutrinos are Majorana particles; the ν_R Majorana mass is the unique gauge-invariant Dirac component and the M_R reproducing the measured neutrino mass scale (1.2×10^{14} GeV) falls mid-window. Definitive exclusion of neutrinoless double beta decay (LEGEND-1000/nEXO class) falsifies the entire chain. Because the outcome of that test depends on the mass ordering, we freeze the decision tree before JUNO reports: detection confirms regardless of ordering; an emptied inverted-ordering band refutes; a normal-ordering funnel outcome is registered in advance as undecidable rather than reinterpreted.

1b. Treating the neutrino sector's continuous parameters as generic draws from the measure reproduces the anarchy scenario, whose successful prediction of large θ_{13} predates this work. Frozen forecasts: normal mass ordering at 95-99.9% (JUNO, within years); the mass sum peaked near 0.06 eV (DESI/Euclid class cosmology, this decade; current data already lean this way); $m_{\beta\beta}$ of order 1-10 meV, small but nonzero, so that null results at next-generation double-beta experiments are the expected outcome without undermining the Majorana

claim. Sharpening (12 August): under the anarchy measure δ_{CP} is uniform and independent of the angles, hence frozen in advance: $P(|\sin \delta_{\text{CP}}| > 0.5) = 66.7\%$, $P(|\sin \delta_{\text{CP}}| > 0.25) = 83.9\%$, median Jarlskog invariant 0.024; an eventual measurement with $|\sin \delta_{\text{CP}}| < 0.25$ (DUNE, Hyper-K) is booked in advance as a miss.

2. No fourth generation; no WIMPs; no new coupled particles beyond ν_R under bare K-minimality.

3. Under the combined accounting of Sec. 8b, the strong-CP zero (34 bits as an address fact, given the measured CKM phase and $\theta_{\text{bare}} = 0$ from the parity-even heat kernel) is cheaper to buy with structure: a θ -solving axion-like sector (10-20 bits) is favoured by ~ 14 bits, and doubles as a dark-matter candidate. Axion-search experiments are thus referees for, not against, the framework.

4. Structure stakes following directly from the chain (registered 12 August): (i) the proton does not decay: the selection eliminated precisely the decay-carrying embeddings (Pati-Salam, SU(5)), so a single confirmed proton decay (Hyper-Kamiokande, from 2027) breaks the full chain of Secs. 5-8; (ii) no light sterile neutrinos: the three heavy ν_R are the complete extension, and a fourth, light neutrino is structure without gate necessity; (iii) no Lorentz violation: the (3,1) signature is a singleton under the gates and a preferred frame costs bits without gate yield. An expectation calendar 2026-2030, listing per stake the referee and the meaning of the other outcome, is kept in the registry.

Further frozen stakes, with their referees, are maintained on the testing page (ee.robingenis.com/toetsing) of this site, which serves as the living registry of this paper's predictions.

11. Discussion

The computation localizes the boundary between law and environment inside particle physics, and does so with falsifiable stakes on both sides of the line; since 12 August the line itself is a stake as well (Sec. 9). What is perhaps most notable methodologically: every wrong turn (three falsifications, an invalidated first scan, two conflicting registrations) is part of the published record, and the final selection emerged from, not despite, that discipline.

APPENDIX A — THE SELECTION FRAMEWORK (ONE PARAGRAPH)

The weight $P = e^{-s}$ follows uniquely from composition and additivity of resistance together with the probability codomain $[0,1]$: continuity is redundant, since an additive function bounded above on a set of positive measure is linear (Ostrowski), and the pathological solutions are unbounded on every such set. Prefix-free description length qualifies as a resistance term with weight $\ln 2$ per bit (universal prior). The philosophical framework is deliberately confined to this appendix and to the rest of this site: the results of the main text stand independently of it.

APPENDIX B — REPRODUCIBILITY

All frozen protocols, outputs and the thirteen analysis scripts (anomaly and Krajewski search, breaking analysis, observer and data gates, Pati-Salam and SU(5) flank scans, endgame, generation round, coupling pipelines, first-order rank computation, b - τ running at one and two loops, α_U point test, S_{dyn} cross-check) are archived with the working records of this site and are available on request; every number in this paper regenerates deterministically from frozen seeds.

REFERENCES (ABBREVIATED)

Connes & Chamseddine (spectral action; Why the Standard Model); Krajewski (classification of finite triples); Chamseddine, Connes & van Suijlekom (Pati-Salam beyond the SM); Gilkey (heat kernel invariants); Foreman-Magidor-Shelah is not used here (see the mathematics page for the companion programme); Solomonoff; Li & Vitányi (universal prior, MDL); Weinberg (anthropic Λ); Tegmark (dimensionality); Hall, Murayama & Weiner; de Gouvêa & Murayama (neutrino anarchy); Renou et al. (real-valued quantum theory excluded); Boddy & Carroll (vacuum decay and Boltzmann brains); PDG for all measured inputs.

Appendix C — The living register, verification, and timestamps

This paper's predictions are maintained as a living register at ee.robiningenis.com/toetsing: at the time of this preprint over thirty-five frozen stakes with explicit failure conditions, an expectation calendar 2026–2035 (first referee: JUNO, neutrino mass ordering), a meta-stake making the law–address boundary itself falsifiable, and a booked track record that includes the misses (three α falsifications, retracted; a Zipf demonstration and a tool-independence stake, both missed and booked; a continuum-concentration stake, frozen and hit the same day).

The core theorem (composition plus codomain force $P = e^{-\lambda s}$, with monotonicity derived rather than assumed) and the orthogonality of the decomposition lemma (flow $\perp$ gauge everywhere; critical orbits stay critical; the Hessian vanishes on gauge directions) have been machine-verified in Lean 4 against mathlib (files Kern.lean and Orthogonaliteit.lean, zero errors; both rest on Lean's standard axioms propext, choice, quotients).

External verifiability: SHA-256 fingerprints of the register are published in the site changelog and the register pages are snapshotted at the Internet Archive on every substantive change. Fingerprint of the register at version-1 time: 51d24ecbc8c6e2572df88d5929b06cf4a81e1441208b475862232f457894ca77; at version-2 time: 239039fdc10dd2074f9977c0793a7dc5de4b890d05bd58c4a5d6c2d5f2b4ea88.

Appendix D — Addendum (18 August 2026): the freeze-point line

Prompted by an external proposal to derive α from the "24-cluster" ($\eta(\tau)^{24}$, Mathieu moonshine, the 24 Niemeier lattices), we mapped the ten routes from $\chi(K3) = 24$ to the fine-structure constant and executed the one with an attainable goal. In F-theory, elliptically fibred K3 is type IIB string theory on P^1 with exactly 24 seven-branes, and the string coupling τ is the fibre modulus (Dasgupta-Mukhi 1996). Enumerating all constant-coupling configurations (script `vriespunt_24.py`; calibration gate: the four known orbifold solutions Z_2, Z_3, Z_4, Z_6 must appear in the count, and all four do) yields 56 configurations: 1 leaves τ free (the Sen orientifold), 9 freeze it at $\tau = i$, 46 at $\tau = e^{i\pi/3}$. The menu of freezable values is $\{i, e^{i\pi/3}\}$: two points, both $SL(2, \mathbb{Z})$ fixed points, both order-1 coupling. This is registered as the **freeze-point stake**: discrete topological data either releases a coupling (address) or locks it onto a duality-symmetric point (law), never onto a generic value such as $1/137.036$. Failure condition: one explicit, consistent construction fixing a coupling, with no remaining continuous moduli, at a non-symmetric point.

The dilaton-free part is computable law: threshold differences between gauge factors at equal Kac-Moody level obey $\Delta_a - \Delta_b = +0.68 (b_a - b_b)$ at the freeze point (script `drempel_verschillen.py`; modular invariance gated numerically at 10^{-8} , $\eta(i)$ matching the closed form to six decimals). The threshold kernel $\text{Im} \tau \cdot |\eta(\tau)|^4$

equals $\det'\Delta$ of the flat torus and is globally maximal at exactly $\rho = e^{i\pi/3}$ (Osgood-Phillips-Sarnak), the same point where 46 of the 56 freeze configurations sit: two independent computations select the same chair.

The stake was stress-tested the same day against its strongest counter-candidates (script `flux_toets.py`, verdicts frozen before computing). In the rigid-CY flux model $W = A\tau + B$ (Gaussian integer fluxes, tadpole ≤ 30) the flux menu holds 266 distinct τ values, 99.6% outside every symmetric-point neighbourhood (ρ is unreachable in principle for this Gaussian-rational menu); an $N=4$ attractor witness gives 27 of 28 horizon values generic. The broad reading "discrete $\Rightarrow$ symmetric point" therefore fails for free discrete data, exactly as the frozen verdict foresaw. The refinement is booked explicitly: *forced* topology ($\chi = 24$ cannot be chosen) fixes only symmetric points; *free* discrete data (fluxes, charges: a choice from a menu) fixes nothing but quantises the address: each flux choice is a different member. A flux-chosen address then costs finitely many bits (8.1 bits in the toy menu; $\log_2 10^{500} \approx 1661$ bits at the IIB landscape anchor), softening the continuum objection to a countable price.

Two closing observations. The Sen-branch observation: the forced menu is order 1 while we measure $\alpha^{-1} = 137$, so within this picture our member demonstrably lives on a free branch, where the coupling is address: the smallness of α itself testifies for the address reading. The moduli bookkeeping (script `vriespunt_moduli.py`): position moduli range from 0 to 9 across the 56 configurations (median 3), and exactly four configurations are fully rigid, all four at a symmetric point: in this class, "no remaining continuous moduli" occurs only at $SL(2, \mathbb{Z})$ fixed points.

Also new since version 1, maintained on the site: the sharpened habitability window and hall map (hydrogen-stability edge $\alpha^{-1} \gtrsim 77$; the carbon island; the Be-8 continent), the derivation audit (the hierarchy costs ~ 5 bits under the log prior; Koide honestly undecided), the LISA fingerprint with a frozen four-branch decision tree, and the recomputed founding images of the framework.

Version 2 generated 18 August 2026; version 1 generated 13 August 2026 from the canonical version at ee.robingenis.com/artikel. The website is the publication of record; this document is a convenience snapshot.