

# The Constant Ledger: Physical Constants as Crystallisation Readouts in the Finite-QEC Substrate

David Elliman  
Neuro-symbolic Ltd  
dave@neusym.ai

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## Abstract

If space is the crystallised, self-correcting register network of the finite-QEC substrate programme [6, 7], then its “fundamental constants” should not be independent dials: most of them ought to be *readouts* of one frozen scale, a finite record alphabet, and a service history. This note updates the constant ledger after the record-action and service-span closures. The constants partition cleanly four ways. (A) A single empirical dimensionful *anchor* — the chiral scale  $\Lambda$ , fixed by the proton mass through  $\Lambda_p = m_p/2\sqrt{2}$  — supplies the lattice spacing and the hadronic/sterile mass units. (B) The bare service rate is no longer a free coupling: the monitored service alphabet is the symmetric closed-record-pair space,  $\text{Sym}^2(16) + 1 = 137$ , so one firing projector has Born weight  $\alpha_0 = 1/137$ . Sector powers of  $\alpha_0$  are then register-touch billing maps. (C) The macroscopic cluster —  $M_P, G, H_0, \Omega_\Lambda$  and  $\rho_\Lambda$  — is produced by the same depth-six residual current and service-span selector:  $N_{\text{lock}} = 9\alpha_0/r_6$ , with  $a = 1$  identified as the R4 completion endpoint inside the current service instrument. (D) The remainder, including the dressed fine-structure constant, the electroweak/top second-anchor sector, and ordinary Standard-Model infrared parameters, is outside the native constant ledger. The classification has a sharp, falsifiable corollary: frozen/readout constants (including  $G$  and the bare service rate) must not drift in time — consistent with lunar-laser-ranging and atomic-clock null results [9–11] — while live service readouts must evolve, the framework predicting  $w(a) = -1 + a/28$ , i.e.  $w_0 = -27/28$ , a concrete target for current and future dark-energy surveys [1, 2, 8]. Every number here is reproduced by a short self-checking program. The firm result is the ledger and the input/output accounting; the remaining caveats are named explicitly: outside-sector completeness, the bare-to-dressed  $\alpha$  shift, and the separate electroweak/top anchor problem. Nuclear binding coefficients are now treated as QCD/EW many-body residuals with local contact-map structure, not as an independent absolute scale.

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## 1 The question

Modern physics carries a long list of “fundamental constants” — Newton’s  $G$ , the Hubble rate  $H_0$ , the dark-energy fraction  $\Omega_\Lambda$ , the fine-structure constant  $\alpha$ , particle masses — and offers no account of why they take the values they do. The suspicion that some are not independent is old: Dirac noticed that certain enormous dimensionless ratios are suspiciously equal and proposed they are linked, even time-varying [3]. Decades of precision searches have since turned the time-variation of constants into a quantitative science [10].

This note asks the question inside one specific model. In the finite-QEC substrate programme, space is not a smooth continuum but the ordered (crystallised) phase of a discrete, self-correcting register network [6, 7]. If that ordered phase is laid down by a crystallisation transition with a definite schedule, then a constant is one of three things: a number *frozen* into the ordered phase at lock-in, an ongoing *rate* of the error-correcting machinery that is still running, or an ordinary low-energy effective parameter. The goal here is to sort the constants into those bins — a “constant ledger” — and to see how few genuinely independent inputs remain.

## 2 One frozen scale

The substrate has a single native infrared length, the lattice spacing  $a_0$ , and a single native hadronic energy, the scale  $\Lambda$  to which it is tied by  $a_0 = \hbar c / \Lambda$ . Everything in this ledger is measured relative to that scale. The current presentation fixes it not by hand but through the best-measured hadronic mass: the proton, via the matter-sector relation

$$m_p = 2\sqrt{2} \Lambda_p \quad \implies \quad \Lambda_p = \frac{m_p}{2\sqrt{2}} \approx 0.332 \text{ GeV}. \quad (1)$$

A useful way to read the rest of this note: *the only empirical dimensionful number that goes in is the proton mass*. If the dimensionful constants are readouts of one frozen scale plus a monitored service history, they must all be expressible as that scale times pure numbers and service spans — and they are, subject to the caveats stated below.

## 3 The dimensionful tower from one anchor

Feeding  $m_p$ , the derived bare service rate  $\alpha_0 = 1/137$ , and the dimensionless service residual  $r_6$  into the proton-to- $G$  accounting chain reproduces the macroscopic tower. Each output has the form  $\Lambda_p \times$  (dimensionless readout or service span); the readouts are built from the record alphabet, the depth-six residual current, and the service-completion lock. The results (computed, not fitted):

Constant	As a readout	Value	vs. measured
$\Lambda_p$ (anchor)	$m_p/2\sqrt{2}$	0.3317 GeV	input
$a_0$ (lattice)	$\hbar c/\Lambda_p$	0.595 fm	definitional
$M_P$	$\Lambda_p\sqrt{990}\alpha_0^3/r_6$	$1.221 \times 10^{19}$ GeV	+0.016%
$G$	$\propto 1/M_P^2$	$6.672 \times 10^{-11}$	-0.032% vs CODATA
$H_0$	$\Lambda_p r_6/(9\alpha_0)$	67.3 km/s/Mpc	-0.17 $\sigma$ vs Planck
$\Omega_\Lambda$	$12\pi/55$	0.6854	+0.10 $\sigma$ vs Planck
$\rho_\Lambda$	$\alpha_0 \Lambda_p^4 r_6$	$2.5 \times 10^{-47}$ GeV <sup>4</sup>	$\approx$ observed
$m_{\nu_R}$	$\alpha_0^2 \Lambda_p$	17.7 keV	matches canon

Two features deserve emphasis. First, no measurement of  $H_0$  is consumed anywhere in the chain —  $H_0$  is an *output*, predicted from the proton mass (the chain is verified to be independent of any assumed Hubble value). Second, the dark-energy density  $\rho_\Lambda$ , the hardest number in cosmology, lands on the observed  $\sim 2.5 \times 10^{-47}$  GeV<sup>4</sup> from the same scale and residual current. That so many independent measured numbers are reproduced, without retuning, from one anchor and one service-span ledger is the central observation of this note.

**Honesty about tiers.** The *form* “one scale plus finite service readouts” is robust. The important recent change is that the bare  $\alpha_0 = 1/137$  rate and the Planck hierarchy are no longer ordinary knobs inside the current instrument:  $\alpha_0$  is the one-projector weight in the 137-label record-pair monitor, and  $M_P$  follows from  $Z_G = 4\alpha_0^2 N_{\text{lock}}$  with  $N_{\text{lock}} = 9\alpha_0/r_6$ . The caveat has moved: these statements are conditional on the reconstruction floor, the sector billing maps, the bare/dressed  $\alpha$  convention, and outside-sector completeness. A hidden register, invalid-state cosmological channel, or non-R4 coupling would reopen the lock. These are real caveats, but they are not free continuous fitting parameters.

## 4 The ledger

Sorting every constant by *how* it arises gives four categories.

Constant(s)	Category	What it is
$\Lambda / m_p$	<b>A: anchor (frozen)</b>	the one dimensionful scale (lock-in)
$a_0, \tau_0, m_{\nu_R}$	<b>A: frozen readout</b>	$\Lambda \times$ fixed service/code powers
$\alpha_0=1/137, 55/8, 12\pi/55,$ $27/28, 1/28, T=9, r_6$	<b>B: record/code</b>	finite record alphabet and code fractions set by record/QEC structure
$M_P, G, H_0, \rho_\Lambda$	<b>C: span/service readout</b>	depth-six residual current plus $N_{\text{lock}} = 9\alpha_0/r_6$
$w(a)$	<b>C: live service law</b>	evolving boundary-service schedule
dressed $\alpha, m_e, \text{EW/nuclear},$ SM set	<b>D: IR / second anchor</b>	ordinary low-energy effective or separate-scale sector

The physical content of the categories is distinct. **A** is the empirical dimensionful anchor and the local frozen readouts that ride on it. **B** is the finite record/code structure: in particular,  $\alpha_0 = 1/137$  is not an adjustable coupling at the bare level but the Born weight of one firing projector in a 137-label monitored record register. **C** are span or service readouts. The Hubble rate is still a clock reading, but its present value is fixed by the completion span rather than inserted as an input; the Planck hierarchy is the nonlocal susceptibility of the same service span. The MOND acceleration scale  $a_M \sim cH_0/2\pi$  sits with this horizon/service category physically, although the late halo ledger

remains a separate dark-sector question.  $\mathbf{D}$  are the familiar low-energy effective quantities, plus the electroweak/top second-anchor sector.

The upshot is a *finite* ledger: stripped of the readouts, the native constant cluster is no longer “many fitted constants.” It is one empirical dimensionful anchor, a forced record alphabet, and a monitored service history. “Why these constants?” then splits into different questions with different answers: the native dimensionful values ride on one scale; the bare dimensionless rate is a finite record count; the macroscopic cluster is a service-span readout; and the dressed/electroweak/top sector is a separate infrared or second-anchor problem.

## 5 A time-variation falsification sheet

The classification is not just bookkeeping: it predicts *which constants may change in time and which may not*, and that is directly testable.

**Frozen constants must not drift.** The anchor and the finite record/code readouts are laid down once; the framework therefore predicts *zero* secular variation for them after lock. This is a genuine constraint, not a free pass, because precision experiments place tight upper bounds on exactly this:

- Newton’s constant: lunar laser ranging limits any drift to  $|\dot{G}/G| \lesssim 10^{-13} \text{ yr}^{-1}$  [11]. The framework requires  $G$  frozen; the null result confirms it. (Notably, the programme’s gravity sector *needs*  $G$  non-running for internal consistency.)
- Fine-structure constant: atomic-clock comparisons bound  $|\dot{\alpha}/\alpha| \lesssim 10^{-17} \text{ yr}^{-1}$  [9, 10]. Again consistent with a frozen value.

A confirmed secular drift in  $G$  or in the physical electromagnetic coupling beyond the ordinary radiative/environmental accounting would falsify their frozen/service classification — and with it this whole picture.

**Service laws must evolve.** The live service laws are the opposite: they *must* change. The cosmic expansion rate  $H_0$  is a clock reading, not an immutable microscopic constant. And the dark-energy equation of state is predicted to evolve, the 28-channel boundary schedule imposing a linear drift

$$w(a) = -1 + \frac{a}{28} \implies w_0 = -\frac{27}{28} \approx -0.964, \quad w_a = -\frac{1}{28} \approx -0.036, \quad (2)$$

in the standard Chevallier–Polarski–Linder parametrisation [1, 8]. This is a sharp, falsifiable prediction for dark-energy surveys: a value  $w_0 > -1$  is exactly the direction recent baryon-acoustic-oscillation data have begun to favour [2], and a future measurement pinning  $w \equiv -1$  exactly (a pure cosmological constant) would contradict it.

In short, the ledger converts a structural classification into an experimental fingerprint: a list of constants that are forbidden to vary, and a small set that are required to.

## 6 What is settled, what is open, what is reserved

**Settled.** The *classification* — anchor/readouts, record/code rates, service-span readouts, and ordinary infrared/second-anchor quantities — is the firm result. The proton-to- $G$  route consumes

no Hubble measurement; the bare service rate  $\alpha_0 = 1/137$  is derived from the clonable closed-record-pair alphabet; the current service-span operator gives  $M_P = 1.221084 \times 10^{19}$  GeV and  $H_0 = 67.27$  km/s/Mpc; and the time-variation pattern is consistent with present bounds.

**Open.** The remaining native caveats are no longer a fuzzy “alpha” or “horizon” problem. They are named: sector billing maps must continue to be checked process by process; the physical dressed coupling  $1/137.035999\dots$  is not closed by the current alpha-escape programme. The bridge–Wilson-web service occupation gives the right sign, form, and a continuum-stable near value, and the newer closed-record-pair route selects the finite Maxwell-contact count  $2 \sum Q^2 - 1 = 31$ , giving the right 137.036 magnitude. But the physical Ward/Kubo self-energy slot does not equal that service projector, and the endpoint-covariance  $\rightarrow F^2$  normal-ordering map remains unproved;  $M_P$  is borderline at the current bare-versus-dressed precision; and the service-span hierarchy is conditional on outside-sector completeness. The electroweak/top scale, formerly a separate second-anchor problem, is now a  $\sim 10\%$  prediction—the radiative byte-power scale  $v/M_P = \alpha_0^8/\sqrt{\lambda}$ , modulo named premises (see the matter–gauge and recent-derivations papers); the nuclear liquid-drop residual is a QCD/EW many-body contact-map problem rather than a third anchor. The MOND scale and late halo ledger sit in the dark-sector papers rather than being closed by this constant ledger alone.

**Reserved.** This is a ledger note, not a replacement for the foundations, cosmology, gravity, and dark-sector papers. The formal record-reconstruction floor, the black-hole entropy normalisation, the HBC scalar-printer channel/spatial locks, and the CMB zero-mode/halo accounting are handled there. The purpose here is to fix *which* numbers are independent and *which* are forbidden, or required, to vary.

## A Reproducibility

Every numerical statement is produced by self-asserting programs in the repository [7] (each exits 0 only if all its internal checks pass):

Program	Role
<code>python_code/constant_ledger.py</code>	Legacy ledger driver for the tower and time-variation falsification sheet.
<code>python_code/g_route_input_ledger.py</code>	The proton-to- $G$ chain; verifies $H_0$ is an output, not an input.
<code>python_code/alpha0_record_pair_symmetry_theorem.py</code>	Derives the 137-label record-pair service alphabet over the 121-label matter-pair alternative.
<code>python_code/alpha0_downstream_billing_map_audit.py</code>	Separates sector billing maps from the dressed- $\alpha$ problem after R14.
<code>python_code/sector_alpha0_billing_dressing_audit.py</code>	Checks which $\alpha_0$ powers bill the R14 service observable and where dressed $\alpha$ matters.
<code>python_code/dressed_alpha_monitor_web_continuum_dos.py</code>	Pins the best alpha-escape service-occupation route at 0.9956 of the observed dressed shift.
<code>python_code/dressed_alpha_sector_billing_no_go.py</code>	Shows that the selected service projector is not yet the physical Ward/Kubo low-energy QED billing slot.
<code>python_code/dressed_alpha_service_kubo_moment_no_go.py</code>	Shows that the charge-weighted Kubo moment is not the monitored service occupation.
<code>python_code/dressed_alpha_maxwell_contact_selector_theorem.py</code>	Selects the finite local Maxwell-contact count $2 \sum Q^2 - 1 = 31$ , a conditional route to CODATA dressed $\alpha$ .
<code>python_code/dressed_alpha_endpoint_contact_map_attempt.py</code>	Attempts the final endpoint-covariance to retarded/local $F^2$ map; leaves the dressed- $\alpha$ contact route conditional, not Locked.
<code>python_code/planck_hierarchy_operator_statement_audit.py</code>	Derives $Z_G = 4\alpha_0^2 N_{\text{lock}}$ and the nine-touch span rule inside the current instrument.
<code>python_code/cosmological_selector_lock_theorem.py</code>	Identifies $N_{\text{physical}} = N_{\text{lock}} = 9\alpha_0/r_6$ as the R4 completion endpoint.
<code>python_code/a1_completion_d2_lift_audit.py</code>	Converts the $a = 1$ lift into a D2 relic-exhaustion first-hitting law.
<code>python_code/a1_episode_count_closure_attempt.py</code>	Closes one open service episode per physical cell under homogeneous R4 covariance.
<code>python_code/heavy_quark_targetb_audit.py</code>	Quantifies the dense-alphabet no-go for heavy-quark masses as static ratios; the electroweak $v$ is now separately predicted by the radiative byte-power route $\alpha_0^8/\sqrt{\lambda}$ .
<code>python_code/item113_t1_t2_local_map_theorems.py</code>	Grounds nuclear volume/surface sign structure in TCH/QEC contact maps while leaving the absolute many-body residual unpinned.

The sector papers state the underlying mechanisms and their claim tiers in full [4–6].

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