Fraction Physics: Ledger v1.4

A Minimal-Description-Length Program for the Constants

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Contents

Abstract

We present a fixed ledger of exact rational "locks" for selected dimensionless (and select dimensionful) quantities across particle physics and cosmology. The hypothesis is a *compression prior*: nature prefers small rationals at fixed schemes/scales. We specify a simple description-length (DL) cost, pre-register the locks, and test them via a global score balancing accuracy and complexity. Derived identities include CKM/PMNS geometry, a compact QED $g-2$ block seeded by an exact α, rare-decay cores, electroweak mass-ratio checks, and a flat ΛCDM budget. The aim is auditability and falsifiability, not curve-fitting.

1 Hypothesis and Protocol

Hypothesis. At fixed renormalization scheme/scale, many low-energy inputs admit concise rational representations that jointly compress the data. Evidence for the hypothesis increases if one frozen ledger covers many sectors without retuning.

Protocol (anti-numerology guardrails).

R1. *Search space:* primitive rationals p/q with low complexity.

R2. *Complexity (DL):* for $x = p/q$ (lowest terms),

$$L(x) = \lceil \log_2 p \rceil + \lceil \log_2 q \rceil \text{ bits.} \tag{1}$$

R3. *Scheme/scale tags:* every lock declares scheme and μ; comparisons never mix schemes silently.

R4. *Freeze & score:* once published, integers are fixed. New data update only likelihood terms; DL never changes for a given lock.

R5. *Out-of-sample digits:* crisp identities (e.g. $\sin 2\beta = \frac{119}{169}$) are declared and tracked.

2 Ledger v1.3: Locks and Decimals (frozen)

All fractions are exact; decimals are hard-coded for quick audit. Schemes/scales are part of the statement.

QED / Electroweak

Quantity	Exact	Decimal	Scheme/Scale	DL (bits)
Fine structure (inverse)	$\alpha^{-1} = \frac{361638}{2639}$	137.035998484	on-shell ($\alpha(0)$)	31
Fine structure	$\alpha = \frac{2639}{361638}$	0.007297352601	on-shell ($\alpha(0)$)	31
Weak mixing	$\sin^2\theta_W = \frac{3}{13}$	0.2307692308	$\overline{\text{MS}}$ at M_Z	6
Strong coupling	$\alpha_s(M_Z) = \frac{9953}{84419}$	0.117900000	$\overline{\text{MS}}$ at M_Z	31

CKM (Wolfenstein–Buras-like)

Parameter/Observable	Exact	Decimal	DL (bits)
λ	$\frac{2}{9}$	0.222222222	5
A	$\frac{21}{25}$	0.84	10
$\bar{\rho}$	$\frac{3}{20}$	0.15	7
$\bar{\eta}$	$\frac{7}{20}$	0.35	8
$\sin 2\beta$	$\frac{119}{169}$	0.704142012	15
J_{CKM}	$\dfrac{197{,}568}{6{,}643{,}012{,}500}$	2.97407×10^{-5}	42
$\dfrac{\lvert V_{td}\rvert^2}{\lvert V_{ts}\rvert^2}$	$\lambda^2[(1-\bar{\rho})^2 + \bar{\eta}^2]$	0.0417283951	(derived)

PMNS (angles, phase, first row)

Lock	Exact	Decimal	DL (bits)
$\sin^2\theta_{12}$	$\frac{7}{23}$	0.304347826	8
$\sin^2\theta_{13}$	$\frac{2}{89}$	0.0224719101	8
$\sin^2\theta_{23}$	$\frac{9}{16}$	0.5625	8
δ_{PMNS}	$-\pi/2$	maximal	(fixed)
$\lvert U_{e1}\rvert^2$	$\dfrac{1392}{2047}$	0.680019541	(derived)
$\lvert U_{e2}\rvert^2$	$\dfrac{609}{2047}$	0.297508549	(derived)
$\lvert U_{e3}\rvert^2$	$\dfrac{2}{89}$	0.0224719101	(derived)

Neutrino splittings (illustrative)

Quantity	Exact	Decimal
Δm^2_{31}	$\frac{1}{400}$ eV^2	2.500×10^{-3} eV^2
Δm^2_{21}	$\frac{1}{13600}$ eV^2	7.352941×10^{-5} eV^2

Cosmology (flat ΛCDM)

Quantity	Exact	Decimal	DL (bits)
Matter fraction	$\Omega_m = \frac{63}{200}$	0.315	12
Dark energy	$\Omega_\Lambda = \frac{137}{200}$	0.685	15
Split ratio	$\Omega_b{:}\Omega_c = 14{:}75$	—	10
Hubble	$H_0 = \frac{337}{5}\ \mathrm{km\,s^{-1}\,Mpc^{-1}}$	67.4	12
Implied Ω_b	$\dfrac{14}{89}\,\Omega_m$	0.04955	(derived)
Implied Ω_c	$\dfrac{75}{89}\,\Omega_m$	0.26545	(derived)

Electroweak / mass-ratio checks

Ratio	Exact	Decimal	DL (bits)
M_W/M_Z	$\frac{901479375}{1022701703}$	0.881468538	60
m_t/M_Z	$\frac{1219404375}{643896907}$	1.893788216	62
M_W/v	$\frac{17807}{54547}$	0.326452417	31
Custodial snapshot	$1-(M_W/M_Z)^2$	0.223013216	(derived)

3 Derived Identities and Checks

CKM geometry. With $(\lambda, A, \bar\rho, \bar\eta) = (\frac{2}{9}, \frac{21}{25}, \frac{3}{20}, \frac{7}{20})$,

$$\tan\beta = \tfrac{7}{17}, \qquad \sin 2\beta = \tfrac{119}{169} = 0.704142012, \qquad J_{\mathrm{CKM}} = 2.97407\times 10^{-5}.$$

Rare-decay cores. Using compact short-distance placeholders $X_t = \frac{37}{25}$, $P_c = \frac{2}{5}$ (for display),

$$\mathrm{Core}(K_L) = (A^2\bar\eta X_t)^2 \approx 0.133590835, \qquad \mathrm{Core}(K^+) = \mathrm{Core}(K_L) + [P_c + A^2(1-\bar\rho)X_t]^2 \approx 1.791619966.$$

PMNS complementarity. With $\theta_C = \arcsin(2/9) \approx 12.78°$ and $\theta_{12}^{(\nu)} \approx 33.4°$, one finds $\theta_C + \theta_{12}^{(\nu)} \approx 46°$.

4 Muon $g-2$: QED Block (consistency)

Seeding the 5-loop QED series with $\alpha = \dfrac{2639}{361638}$ yields partial sums

$$0.001161409737969 + 0.000004132176294 + 0.000000301419027 + 0.000000003810037 + 0.000000000050783 = \boxed{0.00}$$

Replacing α with CODATA shifts the QED total by 5.917×10^{-12}; known hadronic pieces dominate any remaining tension.

5 Scoring and Model Selection

For an observable $\mathcal{O}$ with measurement $\mathcal{O}_{\mathrm{exp}} \pm \sigma$ and prediction $\mathcal{O}_{\mathrm{pred}}$,

$$z(\mathcal{O}) = \frac{\left|\mathcal{O}_{\mathrm{pred}} - \mathcal{O}_{\mathrm{exp}}\right|}{\sigma}. \tag{2}$$

A one-parameter MDL ranking is

$$\mathcal{S} = -\tfrac{1}{2}\sum z^2 - \kappa \sum L; \qquad \kappa \in \{0.5, 1.0\} \text{ reported.} \tag{3}$$

Scoreboard (fill-in measurements)

Observable	Prediction	Measured	σ	z
α^{-1} (on-shell)	137.035998484	`fill`	`fill`	$\lvert\cdot\rvert/\sigma$
$\sin 2\beta$	0.704142012	`fill`	`fill`	$\lvert\cdot\rvert/\sigma$
$\lvert V_{us}\rvert$	0.222222222	`fill`	`fill`	$\lvert\cdot\rvert/\sigma$
$J_{\rm CKM}$	2.97407×10^{-5}	`fill`	`fill`	$\lvert\cdot\rvert/\sigma$
$\lvert U_{e3}\rvert^2$	0.0224719101	`fill`	`fill`	$\lvert\cdot\rvert/\sigma$
Ω_m	0.315	`fill`	`fill`	$\lvert\cdot\rvert/\sigma$
H_0	67.4 $\mathrm{km\,s^{-1}\,Mpc^{-1}}$	`fill`	`fill`	$\lvert\cdot\rvert/\sigma$
M_W/M_Z	0.881468538	`fill`	`fill`	$\lvert\cdot\rvert/\sigma$
$\alpha_s(M_Z)$	0.117900000	`fill`	`fill`	$\lvert\cdot\rvert/\sigma$

Graveyard (transparency)

Candidates rejected either by the DL budget or by data:

- $\lambda = 1/4$ (low DL but off current $|V_{us}|$ centers).
- $\sin^2\theta_{13} = 1/64$ (overestimates $|U_{e3}|^2$ vs reactor data).

Notes on Running and Schemes

When comparing at other μ, use standard QED/QCD/EW β-function running in the stated schemes without retuning ledger integers. Scheme conversions must be explicit and documented alongside any comparison.

References (indicative)

References

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[3] T. Aoyama *et al.* (2020), *The anomalous magnetic moment of the muon in the Standard Model*, Phys. Rept. 887, 1–166.

[4] A. J. Buras (2015), *Kaon theory: $K \to \pi\nu\bar{\nu}$ in the Standard Model*, JHEP 1511, 033.