Fraction Physics DLC Packs — By Evan Wesley

Program: *Fraction Physics Ledger*

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Abstract

Ten simple DLC modules that help teach and standardize Fraction Physics: exact rational locks, MDL accounting, dimensionless recipes, and pre-registration templates.

Contents

Global Conventions and MDL

- Natural units by default: $\hbar = c = k_B = 1$ unless noted. Transcendentals (e.g. π) are explicit and carry **no MDL charge**.
- Rational locks p/q are scored by $L(p/q) = \lceil \log_2 p \rceil + \lceil \log_2 q \rceil$.
- Dimensionless normalization aims to set the dominant kinetic/operator coefficient to **1**; physics is then isolated in a dimensionless potential or source.
- Pre-registration: when a fraction is frozen, list the exact fraction and a decisive block of digits for public audit.

1 DLC–01: Starter Kit — MDL & Nondimensionalization Cookbook

A. MDL Scoring and Integer Discovery

Lock size. $L(p/q) = \lceil \log_2 p \rceil + \lceil \log_2 q \rceil$. Integers use $L(n) = \lceil \log_2 n \rceil$.

Continued fractions (CF). For a real x, compute convergents p_k/q_k; select the smallest-bit p_k/q_k that meets a target tolerance.

Farey/mediants. Given near–neighbors $a/b < c/d$, test the mediant $(a+c)/(b+d)$ if it reduces L while maintaining accuracy.

PSLQ checklist (conceptual). Work with high-precision decimal of a candidate constant X; test integer relations among a basis $\{1, X, X^2, \dots\}$ or among multiples by known scales. Record only relations that reduce to small rationals.

B. Unitization (make the PDE universal)

Pick characteristic scales (L, T, E_0) and define

$$\xi = \frac{x}{L}, \quad \tau = \frac{t}{T}, \quad U = \frac{V}{E_0}. \tag{1}$$

Recipe. Choose E_0 to eliminate the kinetic prefactor. Example (TDSE): with $E_0 = 1/(2mL^2)$ and $T = 1/E_0$,

$$\mathrm{i}\,\partial_\tau \psi = \left[-\partial_\xi^2 + U(\xi,\tau)\right]\psi, \quad \text{(kinetic coefficient 1).} \tag{2}$$

Scoring. The unit kinetic coefficient costs 0 bits; all rationals reside in U or BCs.

C. Pre-registration Template

Name: M–PRED–XX. **Observable:** $\mathcal{O}$. **Exact fraction:** $\boxed{p/q}$. **Digits:** provide a non-overlapping block beyond current measurements. **Scope/units:** fixed; no ambiguity.

2 DLC–02: Electromagnetism Core Locks (HL Units)

A. Maxwell Equations (unit coefficients)

$$\nabla \cdot \mathbf{E} = \rho, \qquad \nabla \cdot \mathbf{B} = 0, \qquad \nabla \times \mathbf{B} - \partial_t \mathbf{E} = \mathbf{J}, \qquad \nabla \times \mathbf{E} + \partial_t \mathbf{B} = 0. \tag{3}$$

Lock. All coefficients are **1** (bit-cost 0 under conventions).

B. Energy, Momentum, and Poynting Theorem

$$u = \tfrac{1}{2}\,(E^2 + B^2), \qquad \mathbf{S} = \mathbf{E} \times \mathbf{B}, \qquad \pi_i = (\mathbf{E} \times \mathbf{B})_i, \tag{4}$$

$$T_{ij} = E_i E_j + B_i B_j - \tfrac{1}{2}\delta_{ij}(E^2 + B^2). \tag{5}$$

Locks. The universal rational **1/2** in u and in the trace term of T_{ij}.

C. Lagrangian (gauge field)

$$\mathcal{L}_{\text{EM}} = -\tfrac{1}{4} F_{\mu\nu} F^{\mu\nu} + J_\mu A^\mu. \tag{6}$$

Lock. Rational **1/4** in the kinetic term.

3 DLC–03: Lagrangian & Noether (Field-Theory Normalizations)

A. Canonical Normalizations

Scalar: $\mathcal{L} = \frac{1}{2}(\partial\phi)^2 - \frac{1}{2}m^2\phi^2 - \lambda\,\phi^4/4!$. Dirac: $\mathcal{L} = \bar{\psi}(\mathrm{i}\partial - m)\psi$. Gauge: $-\frac{1}{4}F^2$. **Locks.** **1/2**, **1/2**, **1/4!**, **1/4**.

B. Euler–Lagrange & Noether

$$\partial_\mu \frac{\partial \mathcal{L}}{\partial(\partial_\mu \varphi)} - \frac{\partial \mathcal{L}}{\partial \varphi} = 0, \qquad \partial_\mu J^\mu = 0 \text{ (symmetry current).} \tag{7}$$

Recipe card. Identify symmetry; compute $\delta\varphi$; form $J^\mu = \sum \frac{\partial \mathcal{L}}{\partial(\partial_\mu \varphi)}\delta\varphi - K^\mu$ (if $\delta\mathcal{L} = \partial_\mu K^\mu$).

4 DLC–04: Renormalization & Running (1-Loop Rational Zoo)

A. QED

$$\beta(e) = \mu\frac{de}{d\mu} = \frac{N_f}{12\pi^2}\,e^3, \qquad \beta(\alpha) = \frac{2N_f}{3\pi}\,\alpha^2, \quad (\alpha \equiv e^2/4\pi). \tag{8}$$

Locks. **1/12**, **2/3** (with explicit π outside MDL).

B. QCD (SU(N_c))

Color factors: $C_F = \frac{N_c^2-1}{2N_c}$, $C_A = N_c$, $T_F = \frac{1}{2}$. One-loop

$$\beta(g) = -\frac{g^3}{16\pi^2}\left(\frac{11}{3}C_A - \frac{4}{3}T_F n_f\right). \tag{9}$$

For SU(3): $C_A = 3$, $T_F = \frac{1}{2} \Rightarrow \beta_0 = 11 - \frac{2}{3}n_f$. **Locks.** **11/3**, **4/3**, **1/2**.

C. Running Templates

$$\alpha(\mu) = \frac{\alpha(\mu_0)}{1 - \beta_1\,\alpha(\mu_0)\ln(\mu/\mu_0)}, \quad \beta_1 = \frac{2N_f}{3\pi}. \tag{10}$$

Note. Logs and π carry no MDL; rational prefactors are the locks.

5 DLC–05: Fluid Dynamics Add-ons

A. Yaglom 4/3 Law (Passive Scalar)

$$\left\langle \delta u_L(r)\left(\delta\theta(r)\right)^2\right\rangle = -\frac{4}{3}\,\chi\,r. \tag{11}$$

Lock. Exact **−4/3**.

B. 2D Enstrophy Cascade

Inertial-range spectrum: $E(k) \sim C\,\eta^{2/3}k^{-3}$. **Lock.** Exponent **−3** (prefactor left empirical).

6 DLC–06: Thermodynamics / Statistical Mechanics Starter

A. Equipartition and Gammas

Each quadratic DOF contributes $\frac{1}{2}T$ to energy (with $k_B = 1$). Monoatomic ideal gas: $\gamma = 5/3$; rigid diatomic: $\gamma = 7/5$. **Locks.** **1/2**, **5/3**, **7/5**.

B. Harmonic Oscillator Partition

$$Z = \frac{1}{2\sinh(\beta\omega/2)}, \qquad \langle E\rangle = \frac{\omega}{2}\coth(\beta\omega/2). \tag{12}$$

Lock. The internal **1/2** structure.

7 DLC–07: Cosmology — FRW Exponents & Distance Recipes

A. Scale-Factor Laws (flat, single-component)

$$a(t) \propto t^{1/2} \text{ (radiation)}, \qquad a(t) \propto t^{2/3} \text{ (matter)}, \qquad a(t) \propto \mathrm{e}^{Ht} \text{ (Λ era)}. \tag{13}$$

Locks. Exponents **1/2**, **2/3**.

B. Comoving Distance Template

For flat ΛCDM,

$$\chi(z) = \int_0^z \frac{dz'}{H_0\sqrt{\Omega_m(1+z')^3 + \Omega_\Lambda}}, \tag{14}$$

with your staged H_0 and $(\Omega_m, \Omega_\Lambda)$ exact fractions. Rational locks sit outside the square-root integrand.

8 DLC–08: Group Theory Quick-Start (SU(2)/SU(3))

A. SU(2)

Pauli basis with $\mathrm{tr}(\sigma^a\sigma^b) = 2\delta^{ab}$; generators $T^a = \sigma^a/2$. Casimir in fundamental: $C_F = 3/4$.

B. SU(3)

Gell-Mann basis with $\mathrm{tr}(\lambda^a\lambda^b) = 2\delta^{ab}$; $T^a = \lambda^a/2$. Casimirs and indices:

$$C_F = \frac{4}{3}, \quad C_A = 3, \quad T_F = \tfrac{1}{2}, \quad d_F = 3,\ d_A = 8. \tag{15}$$

Locks. **4/3**, **3**, **1/2**.

9 DLC–09: Oscillations & Baselines (Two-Flavor)

A. Canonical Probability

$$P_{\alpha\to\beta} = \sin^2(2\theta)\,\sin^2\!\left(\frac{\Delta m^2\,L}{4E}\right), \qquad (\alpha \neq \beta). \tag{16}$$

Lock. The phase **1/4** in natural units.

B. Unit Cards

Keep the 1/4 canonical form; if SI units are required, define a conversion constant K so that $\sin^2(\Delta m^2 L/(4E)) \equiv \sin^2(K\,\Delta m^2[\mathrm{eV}^2]L[\mathrm{km}]/E[\mathrm{GeV}])$. The decimal K is derived from constants (no MDL); the lock remains **1/4**.

10 DLC–10: Contributor Toolkit (Templates & QA)

A. Module Template

Name: M–TAG–NN. **Statement (exact). Locks:** list rationals. **Bit-cost. Scope/assumptions. Test posture. Status.**

B. Pre-Registration Template

Provide exact fraction, digit string beyond current precision, units/scope, and freeze date.

C. QA Checklist

1. Did we unitize to put the kinetic/operator coefficient to 1?
2. Are all rationals simplified and bit-costed?
3. Are transcendentals explicit and uncharged?
4. Is the prediction falsifiable & scope-locked?
5. Are dependencies inherited rather than re-locked?

Staging Table (this DLC pack)

Module	Observable(s) / Content	Frozen value(s) / Locks	Bit-cost	Sector	Status
DLC–01	MDL + unitization	CF/Farey/PSLQ; unit kinetic coeff.	0 (recipes)	Methods	Ready
DLC–02	Maxwell + EMT + Lagr.	unit coeffs; 1/2 in u, 1/4 in $\mathcal{L}$	1+2	EM	Ready
DLC–03	Lagr. + Noether	$1/2, 1/2, 1/4!, 1/4$	small	QFT Core	Ready
DLC–04	1-loop running	QED $1/12, 2/3$; QCD $11/3, 4/3, 1/2$	small	QED/QCD	Ready
DLC–05	Fluids add-ons	$-4/3$ (Yaglom), -3 (2D spectrum)	small	Fluids	Ready
DLC–06	Thermo/Stat	$1/2, 5/3, 7/5$; HO 1/2	small	StatMech	Ready
DLC–07	FRW exponents	$1/2, 2/3$; distance template	small	Cosmology	Ready
DLC–08	SU(2)/SU(3)	$C_F = 4/3, C_A = 3, T_F = 1/2$	small	Group Theory	Ready
DLC–09	Oscillations	phase lock 1/4	small	Neutrino	Ready
DLC–10	Contributor toolkit	templates + QA	0	Methods	Ready