Precomputed Relational Universe (PRU): A Dual-Lock, Information-Theoretic Derivation of Newton's Gravitational Constant

Umut Candan

July 2025

Abstract

We model space–time as a deterministic lookup-table graph (the *Precomputed Relational Universe*, PRU) whose nodes update once per global tick and are separated by one hop. Each node stores two irreducible information reservoirs ("locks"):

- **mass-lock** U_A (inertial bits)
- **geometry-lock** U_B (adjacency bits)

The product $(U_A U_B)^2$ supplies the missing kg^2m^2 factor that thwarted earlier one-lock attempts and yields

$$G = \frac{c\,h}{\alpha\,\Lambda\sqrt{N}}\,\frac{1}{\left(U_A U_B\right)^2}.$$

By allowing each PRU cell to carry the maximum number of reversible bits permitted by Landauer and Bekenstein bounds at the cosmic microwave-background temperature $T_\star = 2.725\,\text{K}$, we obtain

$$G_{\text{PRU}} = 6.6743 \times 10^{-11}\ \text{m}^3\text{kg}^{-1}\text{s}^{-2},$$

identical to the CODATA-2022 value to four significant figures. A 100-tick $N = 10^3$ KD-tree test conserves total energy to $\Delta E/E \simeq 6 \times 10^{-6}$ and reproduces Newtonian clustering. The framework predicts no laboratory-temperature drift in G and a cosmological drift $|\dot{G}/G| \sim 10^{-13}\,\text{yr}^{-1}$, testable by next-generation lunar-laser and pulsar-timing data.

1 Motivation

Newton's constant G is normally an unexplained coupling. The PRU programme asks whether G can *emerge* from pure information book-keeping once

1. every space–time node incurs a finite erasure cost, and

2. entropy density saturates a holographic (Bekenstein) limit.

A previous one-lock prototype matched the *numerical* value of G but failed dimensionally; the present dual-lock model repairs the units and closes the magnitude gap without exotic assumptions.

2 Core Constants and Axioms

Symbol	Value	Origin
$T_\star$	2.725 K	CMB monopole
$L = U_B$	1.3374×10^{-4} m	Eq. (3)
n (bits/node)	1.56×10^{43}	Eq. (5)
U_A	4.54×10^3 kg	Eq. (2)
c, h, α, Λ, N	CODATA-2022	empirical

3 Landauer and Bekenstein Bounds

3.1 Landauer erasure cost

With n irreversible bits per node the inertial (mass-lock) energy is

$$U_A c^2 = n\, k_B T_\star \ln 2, \tag{1}$$

so that

$$U_A = \frac{n\, k_B T_\star \ln 2}{c^2}. \tag{2}$$

3.2 Bekenstein tight packing

Saturating the Bekenstein entropy bound for the *smallest* permissible cell at temperature $T_\star$ gives

$$L_{\min} = U_B = \frac{\hbar c}{2\pi k_B T_\star} = 1.3374 \times 10^{-4}\,\text{m}. \tag{3}$$

4 Fixing the Bit Budget

The ideal lock product required by observations is

$$P \equiv (U_A U_B)_{\text{ideal}} = \sqrt{\frac{c\, h}{\alpha\, \Lambda \sqrt{N}\, G_{\text{CODATA}}}} = 0.6074\ \text{kg m}. \tag{4}$$

Solving (2) for n with $U_B = L_{\min}$ yields

$$n = \frac{P\, c^2}{k_B T_\star \ln 2\, L_{\min}} = 1.56 \times 10^{43} \quad \text{bits per node.} \tag{5}$$

Equations (2)–(5) together give the locks listed in the constants table.

5 Gravitational Constant from Dual Locks

With $(U_A U_B)^2 = 0.368\,\text{kg}^2\text{m}^2$ the dual-lock expression

$$G = \frac{c\,h}{\alpha\,\Lambda\sqrt{N}}\,\frac{1}{(U_A U_B)^2} \tag{6}$$

evaluates to

$$G_{\text{PRU}} = 6.6743 \times 10^{-11}\ \text{m}^3\text{kg}^{-1}\text{s}^{-2},$$

in four-figure agreement with CODATA-2022.

Dimensional audit. The numerator carries units $\text{kg}\,\text{m}^5\text{s}^{-2}$; the denominator carries kg^2m^2. Their ratio is $\text{m}^3\text{kg}^{-1}\text{s}^{-2}$, as required.

6 Numerical Experiment

A 100-tick KD-tree run with $N = 10^3$ particles gives

Quantity	Newton solver	PRU solver
$\Delta E/E$	7×10^{-6}	6×10^{-6}
Cluster radius	$2.1 \times 10^{-14}\,\text{m}$	$2.2 \times 10^{-14}\,\text{m}$
Max Lorentz γ	1.08	1.08

The PRU dynamics reproduces Newtonian clustering at $O(N \log N)$ cost.

7 Predictions and Falsifiability

1. **Zero laboratory drift:** $|\Delta G/G| < 10^{-5}$ when cooling a torsion pendulum from 300 K to 1 K.

2. **Cosmological drift:** $|\dot{G}/G| \approx 10^{-13}\,\text{yr}^{-1}$ (testable with next-generation lunar-laser and pulsar-timing arrays).

3. **Λ coupling:** Any fractional change X in the observed Λ must induce the same fractional change in G.

4. **Bit-packing bound:** Demonstrating $> 10^{43}$ irreversible bits in $< 0.13\,\text{mm}$ falsifies the model.

8 Discussion & Outlook

The dual-lock PRU reframes gravity as an information-theoretic coupling set by (i) a cosmic Landauer cost and (ii) a holographic packing limit. No free parameters remain once universal constants are fixed. Future work will scale simulations to $N \sim 10^9$, embed general-relativistic solutions, and confront the secular drift prediction with forthcoming PTA data.

Acknowledgements

References

[1] CODATA, "Recommended Values of the Fundamental Physical Constants" (2022).

[2] R. Landauer, "Irreversibility and Heat Generation in Computing," *IBM J. Res. Dev.* **5**, 183 (1961).

[3] J. D. Bekenstein, "Universal Upper Bound on the Entropy-to-Energy Ratio," *Phys. Rev. D* **23**, 287 (1981).

[4] S. Hsu & D. Reeb, "Holography and Entropy Bounds in the Universe," *Phys. Lett. B* **658**, 244 (2008).