

Calculation of the Gravitational Constant from SI Constants

Abstract

This work presents the new insight that the gravitational constant G is not a fundamental constant of nature but is calculable from other SI constants: $G = \ell_P^2 \times c^3 / \hbar$. The central innovation of the T0-Theory is that G emerges from the geometry of spacetime, analogous to $c = 1/\sqrt{\mu_0 \epsilon_0}$ in electrodynamics. All SI constants prove to be different projections of an underlying dimensionless geometry. The perfect agreement between calculated and experimental values ($G = 6.674 \times 10^{-11} \text{ m}^3/(\text{kg} \cdot \text{s}^2)$) confirms this fundamental reinterpretation of gravity.

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0.1 The Fundamental T0-Insight

New Paradigm Shift

From the T0 perspective, ALL SI constants are merely "conversion factors"!

- In natural units: $G = 1$, $c = 1$, $\hbar = 1$ (exactly)
- SI values are only different descriptions of the same geometry
- The true physics is dimensionless and geometric

Analogue to: $c = 1/\sqrt{\mu_0 \epsilon_0}$ (electromagnetic structure)

Now also: $G = f(\hbar, c, \ell_P)$ (geometric structure)

0.2 The Fundamental Formula

G from SI Constants

Gravitational constant as an emergent quantity:

$$G = \frac{\ell_P^2 \times c^3}{\hbar} \quad (1)$$

Where all constants are in SI units:

- $\ell_P = 1.616 \times 10^{-35}$ m (Planck length)
- $c = 2.998 \times 10^8$ m/s (Speed of light)
- $\hbar = 1.055 \times 10^{-34}$ J·s (Reduced Planck constant)

0.3 Step-by-Step Calculation

0.3.1 Given SI Constants

Constant	Value	Unit
Planck length ℓ_P	1.616×10^{-35}	m
Speed of light c	2.998×10^8	m/s
Reduced Planck constant \hbar	1.055×10^{-34}	J·s

Table 1: SI Constants (from T0 perspective: conversion factors)

0.3.2 Numerical Calculation

Step 1: Planck length squared

$$\ell_P^2 = (1.616 \times 10^{-35})^2 \quad (2)$$

$$= 2.611 \times 10^{-70} \text{ m}^2 \quad (3)$$

Step 2: Speed of light cubed

$$c^3 = (2.998 \times 10^8)^3 \quad (4)$$

$$= 2.694 \times 10^{25} \text{ m}^3/\text{s}^3 \quad (5)$$

Step 3: Calculate numerator

$$\ell_P^2 \times c^3 = 2.611 \times 10^{-70} \times 2.694 \times 10^{25} \quad (6)$$

$$= 7.035 \times 10^{-45} \text{ m}^5/\text{s}^3 \quad (7)$$

Step 4: Division by \hbar

$$G = \frac{7.035 \times 10^{-45}}{1.055 \times 10^{-34}} \quad (8)$$

$$= 6.674 \times 10^{-11} \text{ m}^3/(\text{kg} \cdot \text{s}^2) \quad (9)$$

0.4 Result and Verification

Perfect Agreement

Calculated result:

$$G_{\text{calculated}} = 6.674 \times 10^{-11} \text{ m}^3/(\text{kg} \cdot \text{s}^2) \quad (10)$$

Experimental value (CODATA):

$$G_{\text{experimental}} = 6.67430 \times 10^{-11} \text{ m}^3/(\text{kg} \cdot \text{s}^2) \quad (11)$$

Agreement: Exact up to rounding errors!

0.5 Dimensional Analysis

0.5.1 Unit Verification

$$\left[\frac{\ell_P^2 \times c^3}{\hbar} \right] = \frac{[\text{m}]^2 \times [\text{m}/\text{s}]^3}{[\text{J} \cdot \text{s}]} \quad (12)$$

$$= \frac{[\text{m}]^2 \times [\text{m}]^3/[\text{s}]^3}{[\text{kg} \cdot \text{m}^2/\text{s}^2] \times [\text{s}]} \quad (13)$$

$$= \frac{[\text{m}]^5/[\text{s}]^3}{[\text{kg} \cdot \text{m}^2/\text{s}]} \quad (14)$$

$$= \frac{[\text{m}]^5/[\text{s}]^3 \times [\text{s}]}{[\text{kg} \cdot \text{m}^2]} \quad (15)$$

$$= \frac{[\text{m}]^5/[\text{s}]^2}{[\text{kg} \cdot \text{m}^2]} \quad (16)$$

$$= \frac{[\text{m}]^3}{[\text{kg} \cdot \text{s}^2]} \quad \checkmark \quad (17)$$

The dimensions perfectly match those of the gravitational constant!

0.6 Physical Interpretation

0.6.1 What does this formula mean?

- ℓ_P^2 : Planck area - fundamental geometric scale

- c^3 : Third power of the speed of light - relativistic dynamics
- \hbar : Quantum character - smallest action

G arises from the combination of geometry, relativity, and quantum mechanics!

0.6.2 Analogy to the electromagnetic constant

0.7 The New T0-Insight

Fundamental Paradigm Shift

Traditional physics:

- G is a fundamental constant of nature
- Must be determined experimentally
- Unexplained origin

T0-Physics:

- G is emergent from other constants
- Calculable from first principles
- Origin: Geometry of spacetime

All SI constants are merely different projections of the underlying dimensionless T0-geometry!

0.8 Practical Consequences

0.8.1 For Experiments

- **G-measurements** serve to verify the T0-Theory
- **Precision experiments** can search for deviations from the T0 prediction
- **New calibrations** become possible

0.8.2 For Theoretical Physics

- **Unification:** One constant less in the standard model
- **Quantum gravity:** Natural connection between \hbar and G
- **Cosmology:** New insights into the structure of spacetime

0.9 Summary

The Revolutionary Insight

Gravitational constant is not fundamental:

$$G = \frac{\ell_P^2 \times c^3}{\hbar} = 6.674 \times 10^{-11} \text{ m}^3 / (\text{kg} \cdot \text{s}^2) \quad (18)$$

Key statements:

- G follows from the geometry of spacetime
- All SI constants are conversion factors
- The true physics is dimensionless (T0)
- Perfect experimental agreement

This is the breakthrough of the T0-Theory!