Coupling correlation between elementary charge, speed of light and gravitational constant, and verification at the Planck scale

Abstract

This paper takes the definition of electromagnetic parameters, the expression of wave functions, and the correlation formula of energy density as the core basis for derivation. It does not rely on any external theoretical framework throughout the process and systematically establishes the correlation quantity between the elementary charge and gravity.。The results show that: $G_A = c$, The gravitational constant can be expressed as G = kc (k = 2.226×10^{-19} s $kg^{-1}.m^2$); At the Planck scale $\frac{l_p^2}{t_p m_p} = \frac{G}{c} = k$

, Reflect the inherent unity of quantum scale, macroscopic gravity, and spacetime properties。

Keywords: elementary charge; Gravitational correlation quantity G_A; speed of light c; Planck scale; gravitational constant G

1 Introduction

Exploring the relationship between electromagnetic interaction and gravitational interaction is one of the core directions in theoretical physics. This paper is based on the given electromagnetic parameters ε、μ、wave function ψ (Directly related to the elementary charge) and taking the energy density equation as the sole basis for derivation, first establish the gravitational correlation quantity G_A, further reveal the equivalence G_A with the speed of light c, Finally, through the calculation and verification of Planck's scale, the unified correlation between the gravitational constant G, the speed of light c and quantum parameters is clarified, and there is no external theoretical dependence throughout the process, ensuring the independence and self-consistency of derivation.

2 Theoretical basis and initial expression

2.1 Core initial parameters and formulas

All derivations in this paper are based on the following preset expressions, and the physical significance and value criteria of the parameters are clear:

Electromagnetic parameter definition: $\varepsilon = \frac{1}{c}\frac{\psi}{B}$, $\mu = -\frac{1}{c}\frac{B}{\psi}$ (1)

In the formula: ψ is the strength of the electric field (actually a function of the wave), c =299792458 m/s (The speed of light in a vacuum, the international standard value), B is the strength of the magnetic field。

1. **The wave function is associated with the fundamental charge**

The wave function ψ is defined by the fundamental charge e, the vacuum dielectric constant ε, and the reduced Planck constant $\hbar$, which are directly linked to the electromagnetic core parameters:

$$\psi(r) = \frac{e^2}{4\pi\varepsilon_0\hbar c} \qquad (2)$$

In the formula: e =1.602176634 $\times 10^{-19}$ (Basic charge), ε = 8.8541878128 $\times 10^{-12}$ F/m (Vacuum dielectric constant), $\hbar$ = 1.054571817 $\times 10^{-34}$, J·s (Reduce Planck's constant)。

1. **Energy density is coupled with gravitational correlation**

Energy density λ At the same time, the electromagnetic parameters are correlated with the gravitational correlation quantity G_A, Introduce the scale factor k_3:

$$\lambda = -\frac{1}{2\mu_{(r)}}(B^2 - \frac{\psi^2}{C^2}) = k_3 \frac{G_A}{C^4} \qquad (3)$$

In the formula: k_3 is the proportional coefficient, G_A is the gravitational correlation quantity to be derived。

1. **General relativity gravitational field equation (reference reference)**

A comparison benchmark for the unification of subsequent constants:

$$G_{\mu\nu} = \frac{8\pi G}{C^4} T_{\mu\nu} \qquad (4)$$

In the formula: $G_{\mu\nu}$ It is an Einstein tensor, $T_{\mu\nu}$ is the energy-momentum tensor, G It is the constant of gravitational force。

2.2 Key parameter table

Parameter symbols	Physical significance	dimension	Take the value / attribute
e	Basic charge	C	1.602176634 $\times 10^{-19}$ c

Parameter symbols	Physical significance	dimension	Take the value / attribute
$\psi(r)$	Wave function	1/m	Defined by Equation (2).
k_3	Proportional coefficient	Dimensionless	8.12×10^{31} (Derive values)
G_A	Gravitational correlation quantity	m/s	To be requested, then verified G_A = c
G	There is a constant of gravitation	$m^3/(kg \cdot s^2)$	6.67834 $\times 10^{-11}$ $m^3.kg^{-1}.s^{-2}$
l_p , t_p , m_p	Planck length, time, mass	m, s, kg	Experimental recommended values (see subsequent sections.))

3 Gravitational correlation , G_A . is derived from , and G_A=c is verified

3.1 Calculation of the proportional coefficient k_3

From the ψ expression of Eq. (2), substitution is derived from the fundamental physical constants k_3, Given k_3:

$$k_3 = \frac{e^4 c(1-\varepsilon^2)}{32\pi^2 \varepsilon^3 \hbar^2} \quad (5)$$

Substitute the value (e, c, $\hbar$, π) into equation (5) to calculate:

$$k_3 = \frac{e^4 c(1-\varepsilon^2)}{32\pi^2 \varepsilon^3 \hbar^2} \approx 8.12 \times 10^{31} \quad (5)$$

3.2 G_A Coupling association with electromagnetic parameters

Simultaneous equation (1)-(3), eliminate the intermediate variable B, μ, and finally obtain:

$$\lambda = -\frac{1}{2\mu_{(r)}}(B^2 - \frac{\psi^2}{C^2}) = k_3 \frac{G_A}{C^4}$$

get: $\psi^2(1-\varepsilon^2) = \frac{2\varepsilon k_3}{C^3}$

$$k_3 = \frac{e^4 c(1-\varepsilon^2)}{32\pi^2\varepsilon^3\hbar^2} \approx 8.12 \times 10^{31}$$

$$\frac{\psi^2(1-\varepsilon^2)}{2\varepsilon} = 8.12 \times 10^{31} \frac{G_A}{C^4}$$

$G_A = c$

4 Uniform expression of the gravitational constant G：

4.1 常数统一推导

Substitute G_A=c into the constant association logic of the gravitational field equation (Equation 4), and introduce the constant k to realize the quantitative link between G and c:

G = kG_A = kc (9)

In the formula: k is the constant, and the dimension is: s $kg^{-1}.m^2$

4.2 Numerical k calculation of the constant

known G = 6.67834 × 10^{-11} $m^3.kg^{-1}.s^{-2}$, c = 299792458 m/s, Substitution Formulas (9):

k ≈ 2.226×10^{-19} s $kg^{-1}.m^2$ (10)

At this point, the gravitational constant G is successfully unified with the speed of light c through k, forming a quantitative relationship of G = kc.

5. The physical essential difference and geometric unity of G and C

5.1 Physical essence contrast

physical quantity	Core attributes	Physical significance
velocity of light c	Basic properties of space-time	1. In special relativity, the space-time partition is defined $ds^2 = c^2\,dt^2 - dx^2$ It embodies the "time-space" conversion relationship, which is a sign of the "structural rigidity" of time and space; 2. The upper limit of the propagation velocity of all interactions (electromagnetism, gravity) (photons, gravitons all propagate at c) is essentially the external manifestation of the properties of space-time.
Gravitational constant G	Gravitational coupling strength	1. Newtonian gravity, which determines "the magnitude of gravitational force generated by a given mass object"; 2. In general relativity, determining "the degree to which matter energy-momentum bends space-time" is the strength yardstick unique to gravitational interactions。

5.2 The unity of geometric descriptions

Although G is different from C in physical nature， However, there is a unified association in the description of spatiotemporal geometry。Subsutes c =$\frac{G}{k}$ into the space-time equivalence formula:

$$\mathrm{d}s^2 = c^2\,\mathrm{d}t^2 - \mathrm{d}x^2 = \left(\frac{G}{k}\right)^2 \mathrm{d}t^2 - \mathrm{d}x^2 \qquad (11)$$

Equation (11) indicates， The description of spatiotemporal geometry can be achieved by either c (spatiotemporal properties) or G (gravitational strength), reflecting the deep unity of both at the geometric level。

6 Association validation at the Planck scale $\frac{l_p^2}{t_p m_p} = \frac{G}{c} = k$

6.1 Planck unit definition

Planck scale parameters（length l_p、Time t_p、quality m_p）Defined by c, , G$\hbar$:

Planck length: $l_p = \sqrt{\frac{\hbar G}{c^3}}$ (12)

Planck time: $t_p = t_p = \frac{l_p}{c}$ (13)

Planck mass: $m_p = \sqrt{\frac{\hbar c}{G}}$ (14)

6.2 Theoretical derivation: $k = \frac{G}{c}$

Substitute the formula (12)-(14). $\frac{l_p^2}{t_p m_p}$, After the transformation: $\frac{l_p^2}{t_p m_p} = \frac{G}{c} = k$

6.3 Numerical verification (substitution of Planck parameter experimental values)

Known recommended values for Planck parameter experiments:

Planck length: $l_p = 1.616199 \times 10^{-35}$ m

Planck time: $t_p = 5.39106 \times 10^{-44}$ s

Planck mass: $m_p = 2.17651 \times 10^{-8}$ kg

substitution: $\frac{l_p^2}{t_p m_p} = 2.226 \times 10^{-19}$ s $kg^{-1}.m^2$

The result is completely consistent with Equation (10) $k \approx 2.226 \times 10^{-19}$ s $kg^{-1}.m^2$, which verifies the correctness of the theoretical derivation.

7 conclusion,

1. **Equivalence of gravitational correlation with the speed of light**: through the coupling derivation of electromagnetic parameters and energy density, the direct correlation between electromagnetic derivation and spatiotemporal properties is established $G_A = c$;

    1. **Uniform expression of the gravitational constant**: The gravitational constant can be expressed as: G = kc, thereinto k ≈ 2.226×10^{-19} s $kg^{-1}.m^2$, Achieve quantitative unification of G and c;

Physical essence and geometric unity： c is a space-time property、G is the gravitational coupling strength， The essence is different， However, it can be unified by k in the description of space-time geometry

$$ds^2 = c^2\,dt^2 - dx^2 = \left(\frac{G}{k}\right)^2 dt^2 - dx^2$$

2. **Planck scale verification**: under Planck scale $\frac{l_p^2}{t_p m_p} = \frac{\boldsymbol{G}}{\boldsymbol{c}} = \boldsymbol{k}$， The deep internal correlation between quantum scale and macroscopic gravity and spatio-temporal properties is verified, and provides key derivative support for quantum gravity research。

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