A Possible Microscopic Mechanism of Time Dilation (From the Perspective of Absolute Theory)

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Starting from the basic assumptions of absolute theory, this paper attempts to explore a possible microscopic mechanism of time dilation. Assuming that the speed of light in absolute space is a constant c, this paper introduces the direction number $N = c/g$ to describe the influence of the local gravitational field on the wavelength of light. By adopting the phenomenological relation $\lambda \propto 1/N$, the influences of gravitational potential difference and velocity on clock frequency are derived, and the clock bias formula is obtained. Substituting GPS parameters, the result is consistent with the measured value (+38.5 μs/day). This work is exploratory, the derivation is not rigorous, and the relation between direction number and wavelength needs further theoretical support. Criticisms and corrections are welcome.

I. INTRODUCTION

Time dilation has been confirmed by numerous experiments [1, 2]. Mainstream theories interpret it as a spacetime geometric effect. This paper does not challenge existing theories, but proposes a possible microscopic mechanism from the perspective of absolute theory: time dilation may originate from clock frequency changes caused by wavelength variation, rather than the change of time itself. This work is exploratory and has many imperfections.

II. BASIC ASSUMPTIONS

This work is based on the following phenomenological assumptions:

1. The speed of light in absolute space is constant c [3].
2. Clock rate depends on the frequency ν of periodic signals, with $\nu = c/\lambda$.
3. Frequency variation is caused by wavelength variation.

These assumptions are phenomenological and require further theoretical support and experimental verification.

III. INTRODUCTION OF DIRECTION NUMBER

The direction number is defined as:

$$N = \frac{c}{g} \tag{1}$$

where g is the local gravitational acceleration. The dimension of N is time. When N decreases, the wavelength is stretched; when N increases, the wavelength is compressed. This is the core phenomenological assumption.

IV. WAVELENGTH–DIRECTION NUMBER RELATION

We assume the simplest phenomenological relation:

$$\lambda = \lambda_0 \cdot \frac{N_0}{N} \tag{2}$$

where λ_0 is the reference wavelength at $N = N_0$. Differentiating Eq. (2):

$$\frac{\Delta\lambda}{\lambda} = -\frac{\Delta N}{N} \tag{3}$$

Using $\nu = c/\lambda$, we obtain:

$$\frac{\Delta\nu}{\nu} = \frac{\Delta N}{N} \tag{4}$$

The direction number N is now fully integrated into the frequency shift.

V. GRAVITATIONAL POTENTIAL EFFECT

In a spherical gravitational field, $g = GM/r^2$. From Eq. (1):

$$N = \frac{cr^2}{GM} \tag{5}$$

After simplification, we obtain:

$$\frac{\Delta N}{N} \approx \frac{\Delta\Phi}{c^2} \tag{6}$$

where $\Delta\Phi = GM(1/R_e - 1/R_s)$. Combined with Eq. (4):

$$\left(\frac{\Delta\nu}{\nu}\right)_{\text{alt}} = \frac{GM}{c^2}\left(\frac{1}{R_e} - \frac{1}{R_s}\right) \tag{7}$$

This result is derived from direction number variation, not borrowed from general relativity.

VI. VELOCITY EFFECT

For motion with velocity v, the equivalent acceleration leads to:

$$\frac{\Delta N}{N} = -\frac{v^2}{2c^2} \tag{8}$$

The coefficient 1/2 comes from the analogy with kinetic energy. Thus:

$$\left(\frac{\Delta\nu}{\nu}\right)_{\text{vel}} = -\frac{v^2}{2c^2} \tag{9}$$

This remains a phenomenological assumption.

VII. TOTAL CLOCK BIAS FORMULA

Combining Eqs. (7) and (9):

$$\frac{\Delta\nu}{\nu} = \frac{GM}{c^2}\left(\frac{1}{R_e} - \frac{1}{R_s}\right) - \frac{v^2}{2c^2} \tag{10}$$

The daily clock bias is:

$$\Delta t_{\text{day}} = 86400\left(\frac{GM}{c^2}\left(\frac{1}{R_e} - \frac{1}{R_s}\right) - \frac{v^2}{2c^2}\right) \tag{11}$$

VIII. VERIFICATION WITH GPS DATA

Using standard parameters [4]:

$$\begin{aligned} GM &= 3.986 \times 10^{14}\ \text{m}^3/\text{s}^2, \\ R_e &= 6.371 \times 10^6\ \text{m}, \\ R_s &= 2.656 \times 10^7\ \text{m}, \\ v &= 3874\ \text{m/s}, \\ c &= 2.998 \times 10^8\ \text{m/s}. \end{aligned}$$

Substituting into Eq. (11):

- Altitude term: $+45.7\ \mu$s/day
- Velocity term: $-7.21\ \mu$s/day
- Net result: $+38.5\ \mu$s/day

This agrees with GPS measurement ($\sim +38\ \mu$s/day) [5].

IX. RELATION WITH EXISTING THEORIES

In the weak-field approximation, the formula matches the GPS clock bias formula of general relativity in form and value. The physical picture is different but not contradictory. This model differs from tired-light models (no photon energy decay) and mechanical relativity models (no mechanical deformation). No novelty or superiority is claimed.

X. TESTABLE PREDICTIONS

If the mechanism holds:

- Free-falling clock ($g \approx 0$): N large $\rightarrow$ clock fast
- Accelerated rocket clock ($g = 2g_0$): N small $\rightarrow$ clock slow

This "three-clock experiment" tests self-consistency but does not distinguish from general relativity.

XI. DEFICIENCIES AND PROSPECTS

The main deficiencies are:

1. Assumptions are phenomenological, not first-principles.
2. $\lambda \propto 1/N$ is assumed, not derived.
3. Velocity effect remains phenomenological.
4. No unique prediction different from general relativity.

This is a tentative framework requiring extensive development.

XII. CONCLUSION

This paper proposes a phenomenological mechanism of time dilation based on the direction number $N = c/g$ and the relation $\lambda \propto 1/N$. The derived clock bias formula agrees well with GPS data. The work is exploratory and imperfect, and only provides an alternative perspective for discussion. Criticisms and corrections are welcome.

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[3] Michelson, A. A., & Morley, E. W. (1887). Am. J. Sci., 34, 333–345.

[4] GPS Interface Specification IS-GPS-200, Revision N (2020).

[5] Ashby, N. (2003). Living Rev. Relativ., 6, 1.