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# Questioning the Lorentz Factor in Special Relativity Based on the Value of the Maximum Anisotropy of Light Speed in the Michelson-Morley Experiment

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*Article*

# Questioning the Lorentz Factor in Special Relativity Based on the Value of the Maximum Anisotropy of Light Speed in the Michelson-Morley Experiment

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**Abstract:** Newton's classical dynamics accurately describes the motion of objects moving at speeds much less than the speed of light and has been extensively validated under these conditions. Any new dynamics formula must reduce to Newton's equations at low velocities. Einstein's theory of special relativity, which utilizes the Lorentz factor, provides a revised view of space-time and also conforms to Newton's equations for low speeds. However, the Lorentz factor assumes that the maximum anisotropy of the speed of light is zero, a condition not fully supported by experimental evidence. The Michelson-Morley Experiment, conducted at a speed far less than that of light, suggests that while the measured anisotropy is very small, it is not zero. This small value could imply the existence of undiscovered physical laws. To address this, we propose the Yuyunrui factor, which includes two hyperparameters, $\alpha$ and $\beta$, encompassing various possible models. In this framework, the Lorentz factor represents a special case with $(\alpha = 0, \beta = 1)$ and zero anisotropy. We categorize the $(\alpha, \beta)$ combinations into four broad types based on their scaling effects and describe these in detail. Future experiments at higher speeds will be essential to accurately determine the true value of the maximum anisotropy of the speed of light and to refine the proposed factor.

**Keywords:** Lorentz factor; special relativity; the maximum anisotropy of light speed in the Michelson-Morley experiment

## 1. Introduction

Newton's classical kinetic energy equation[1] describes the laws of motion for objects moving at speeds much less than the speed of light. This discovery is one of the most significant achievements in our quest to understand the natural world's motion. As our understanding evolves from basic to more complex phenomena, we must continually refine and expand upon established laws to accommodate new physical insights. Newton's kinetic energy equation, although thoroughly verified for low-velocity conditions, also requires adjustments to address their limitations when approaching higher velocities.

Since Newton's kinetic energy equation has been validated extensively at speeds much less than the speed of light, they serve as a crucial foundation for analyzing motion in this regime. Consequently, any new, more comprehensive kinetic energy equations must approximate Newton's kinetic energy equation at low velocities. This prerequisite ensures continuity and accuracy in our theoretical framework.

Einstein's special relativity[2], underpinned by the Lorentz factor[3], introduces a novel perspective on space and time, encapsulated in the concept of time dilation[4,5]. This theory represents another monumental step in understanding the laws of motion, fulfilling the requirement that Newton's kinetic energy equation is an approximate solution at low velocities.

The Lorentz factor's validity is predicated on the assumption that the maximum anisotropy of the speed of light, as measured by the Michelson-Morley Experiment, is strictly equal to zero. However, experimental results have shown that while the maximum anisotropy of the speed of light is indeed very small, it is not exactly zero. This subtle discrepancy raises questions about the universal applicability of the Lorentz factor. The smaller the maximum anisotropy, the narrower the gap between the Lorentz factor and the true factor might be, but it also suggests that there could be new physical laws yet to be discovered, concealed within these minute differences. The Michelson-Morley Experiment, which is based on the Earth's orbital speed around the Sun at 30 kilometers per second, might be limited by the relatively slow velocity compared to the speed of light. If future experiments could be conducted at higher relative speeds, it is conceivable that the observed anisotropy might change, potentially revealing new aspects of physical law. Therefore, to assume the absolute validity of the Lorentz factor based solely on the small errors of the Michelson-Morley Experiment may not align with the rigorous spirit of scientific inquiry, which demands a thorough examination of all possibilities, especially in the face of such minute but potentially deviations.

While we challenge the Lorentz factor, we do not dispute the classical mass-energy equation[2,6] ($E = mc^2$) or the observable phenomenon of time dilation, which has been confirmed through numerous experiments[7]. Our focus is on the plausibility of the Lorentz factor and exploring alternative factors that could provide a more accurate description of motion.

To address these issues, we consider the possibility that the true factor governing the observed phenomena might be obscured when the currently measured maximum anisotropy of the speed of light, denoted as $\varepsilon$, as determined by the Michelson-Morley experiment, is less than $10^{-17}$[8]. The correct factor must simultaneously satisfy two key conditions: first, the kinetic energy equation derived from this factor must reduce to Newton's kinetic energy equation at low velocities, and second, the maximum anisotropy of the speed of light predicted by this factor must align with the experimentally observed maximum anisotropy.

Based on these considerations, we propose the Yuyunrui factor, which incorporates two hyperparameters, $\alpha$ and $\beta$, designed to encompass all potentially valid factors. Notably, the Lorentz factor emerges as a special case of the Yuyunrui factor when $(\alpha = 0, \beta = 1)$, under the condition that the maximum anisotropy of the speed of light is exactly zero. We categorize the combinations of $(\alpha, \beta)$ into four major groups based on their respective scaling effects, and we describe these effects in detail. Identifying the correct combination of $(\alpha, \beta)$ that applies to the real world will necessitate further, more rigorous experiments, especially considering the latest measurements of the maximum anisotropy of the speed of light.

In summary, while acknowledging the profound impact of Newton's kinetic energy equation and Einstein's special relativity on our understanding of the physical world, we must address the unresolved issues surrounding the currently measured maximum anisotropy of the speed of light. By refining our theoretical models and subjecting new hypotheses to rigorous empirical testing, we can advance our understanding of the true laws governing motion in nature.

## 2. Method

### 2.1. Premise of Analysis: The Maximum Anisotropy of the Speed of Light is Not Strictly Equal to Zero

Our analysis is grounded on the premise that the maximum anisotropy of the speed of light, measured as $\varepsilon < 10^{-17}$ in the Michelson-Morley experiment[9], is indeed small, but not strictly equal to zero. We hypothesize that the true factor may be concealed under the assumption that this small but non-zero value of the maximum anisotropy of the speed of light reflects the underlying physical reality.

Based on the Pythagorean Theorem, the relationship between $t$ and $t_\theta^m$ can be expressed by the following equation:

$$(v \cdot t + c \cdot t_\theta^m \cdot s_v \cdot cos\theta)^2 + (c \cdot t_\theta^m \cdot s_p \cdot sin\theta)^2 = (c \cdot t)^2 \tag{1}$$

According to Equation (1), for $t_\theta^m \geq 0$, the following relational equation is satisfied:

$$t_\theta^m = \frac{\sqrt{\frac{v^2}{c^2} \cdot \cos^2\theta \cdot {s_v}^2 + (\cos^2\theta \cdot {s_v}^2 + \sin^2\theta \cdot {s_p}^2) \cdot \left(1 - \frac{v^2}{c^2}\right)} - \frac{v}{c} \cdot \cos\theta \cdot s_v}{\cos^2\theta \cdot {s_v}^2 + \sin^2\theta \cdot {s_p}^2} t \tag{2}$$

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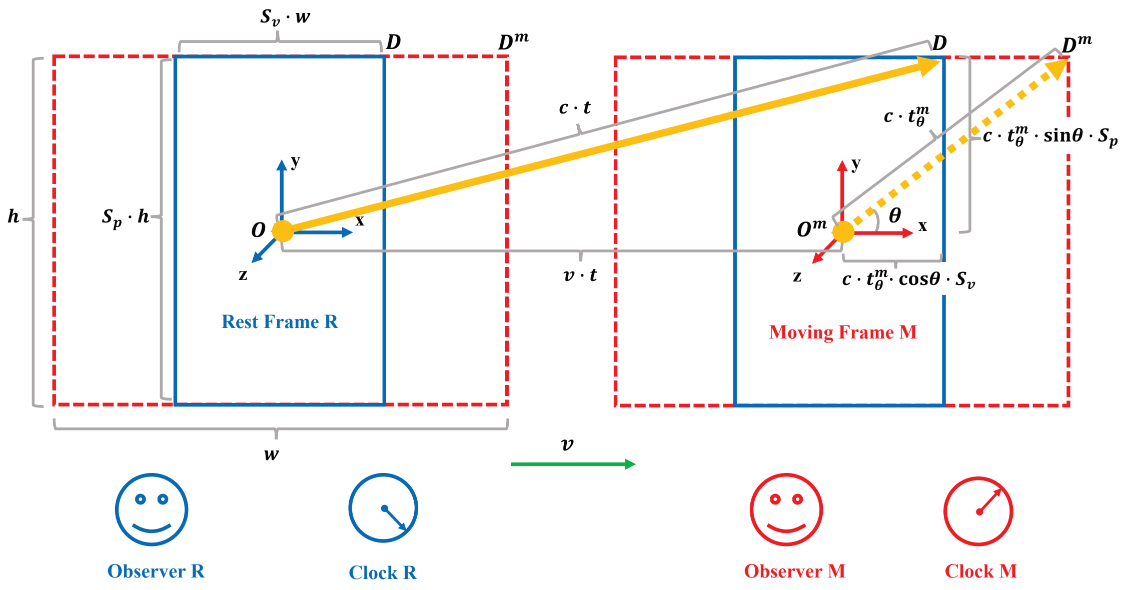


**Figure 1.** The red dotted lines depict the dimensions of the object as observed in the moving frame M, where $h$ represents the dimension perpendicular to the direction of motion and $w$ represents the dimension along the direction of motion. The blue solid lines illustrate the shape of the object as observed in the rest frame R under the scaling effects of special relativity. Here, $s_v$ is the dimensional scaling factor in the direction of motion, and $s_p$ is the scaling factor perpendicular to the direction of motion, with $s_v = 1$ and $s_p = \sqrt{1 - v^2/c^2}$ under the Lorentz factor. The angle $\theta$ is between the light ray observed by observer M and the velocity of motion, ranging from $[0, \pi]$, and it is not affected by velocity-induced scaling, as the object's size remains constant to the observer in the moving frame. Points $D^m$ and $D$ represent the same location on the moving object. Point $D^m$ is where the light ray reaches as observed by observer $M$ in the moving frame along the $\theta$, and point $D$ is where the light ray reaches as observed by observer $R$ in the rest frame under the scaling effect. The variable $t$ denotes the time for light to travel from $O$ to $D$ as recorded by the clock $R$ in the rest frame, and $t_\theta^m$ is the time for light to travel from $O^m$ to $D^m$ as recorded by the clock $M$ in the moving frame.

where the angle $\theta$ is defined as the angle between the direction of light propagation as observed by the observer $M$ within the moving frame and the velocity of the object. This angle $\theta$ ranges from 0 to $\pi$ and is not affected by the scaling effect due to changes in the object's speed, as the object's size remains constant to the observer $M$ in the moving frame. When $\theta = 0$, the direction of light propagation is the same as the direction of the object's motion. Conversely, when $\theta = \pi$, the direction of light propagation is entirely opposite to the direction of the object's motion. It is important to note that the angles $\theta$ and $2\pi - \theta$ represent the same physical situation, both corresponding to the angle $\theta$.

We define the unidirectional time scaling factor between $t_\theta^m$ and $t$ as $\delta_\theta$, where:

$$\delta_\theta = \frac{t_\theta^m}{t} \tag{3}$$

The unidirectional time scaling factor $(\delta_\theta)$ characterizes the relative passage of time for different directions within a moving object. Notably, $\delta_\theta = 0$ signifies complete stasis of time in the direction characterized by angle $\theta$. Values of $0 < \delta_\theta < 1$ correspond to a slowdown in the passage of time, while $\delta_\theta = 1$ indicates no relative change. Conversely, $\delta_\theta > 1$ suggests an acceleration of time in that specific direction.

To understand the time dilation effect, it is essential to define a clock as a timekeeping instrument based on periodic reciprocating motion. This principle underlies all clocks, whether mechanical,

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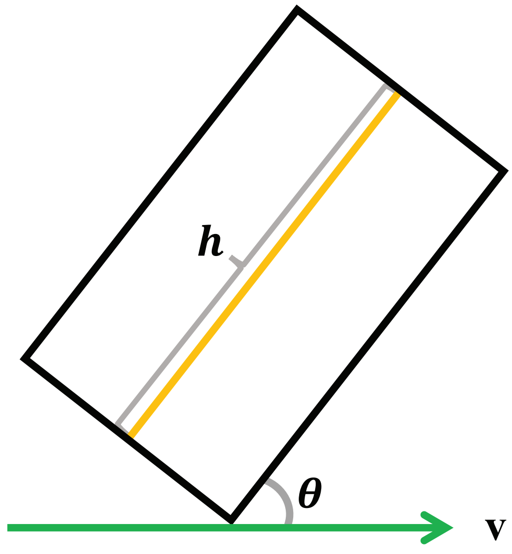


**Figure 2.** A light clock consists of two mirrors separated by a fixed distance $h$, $h$ is the distance that light travels from one mirror to the other in the light clock. A beam of light travels from one mirror to the other and back again, completing a round trip. Each round trip constitutes one "tick" of the clock. The axis of the light clock is positioned at an angle $\theta$ with respect to the direction of motion, where $\theta$ ranges from 0 to $\pi$. When light propagates from one mirror to the other at an angle $\theta$, it returns from the second mirror to the first at an angle of $\pi - \theta$.

electronic, or atomic. In a mechanical clock, the periodic motion is provided by a pendulum or balance wheel, which drives the clock's gears and hands. An electronic clock relies on the oscillation of a quartz crystal, which vibrates at a precise frequency when an electric current is applied, converting these vibrations into electrical impulses for timekeeping. In an atomic clock[10,11], vibrations of atoms like cesium or rubidium, when exposed to an electromagnetic field, oscillate at a highly stable frequency, making atomic clocks the most accurate.

Applying this principle to the analysis of time dilation, we introduce the Einstein Light Clock[2,4], which is a theoretical apparatus for measuring time intervals based on the behavior of light. It consists of two mirrors separated by a fixed distance $h$, which is the distance light travels from one mirror to the other in a light clock. A beam of light travels from one mirror to the other and back again, completing a round trip. Each round trip constitutes one "tick" of the clock. This setup allows time to be measured based on the number of ticks the light completes between the mirrors. To analyze the relationship between the time dilation effect and the $\theta$ angle, we consider placing the light clock at a $\theta$ angle to the direction of motion, as shown in Fig. 2. Here, $\theta$ ranges from 0 to $\pi$. When light propagates from one mirror to the other at an angle $\theta$, it returns from the other mirror to the starting mirror at an angle $\pi - \theta$. This placement allows for examining how the effect of time dilation on the light clocks varies with $\theta$.

When the light clock in the moving frame is positioned at an angle $\theta$ to its direction of velocity, the time interval for each tick of the light clock in the moving frame can be measured in two different frames of reference. The time interval measured in the rest frame is denoted as $T_\theta^r$, and the time interval measured in the moving frame is denoted as $T_\theta^m$. These intervals can be expressed respectively as follows:

$$T_\theta^r = \left(\frac{1}{\delta_\theta} + \frac{1}{\delta_{\pi-\theta}}\right) \cdot \frac{h}{c} \tag{4}$$

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$$T_\theta^m = \frac{2h}{c} \tag{5}$$

The time scaling factor of the light clock $\zeta(\theta)$, which represents the ratio of the time intervals measured by the clocks in the moving frame and the rest frame, is defined as follows:

$$\begin{aligned}\zeta_\theta &= \frac{T_\theta^m}{T_\theta^r} \\ &= \frac{1-\frac{v^2}{c^2}}{\sqrt{(\cos^2\theta \cdot s_v{}^2 + \sin^2\theta \cdot s_p{}^2) - \frac{v^2}{c^2} \cdot \sin^2\theta \cdot s_p{}^2}}\end{aligned} \tag{6}$$

The time scaling factor of the light clock $\zeta_\theta$ is related to both the velocity $v$ of the moving object and the angle $\theta$. The correlation with the velocity $v$ reflects the time dilation effect on moving objects as described by special relativity. Specifically, the time dilation's effect on a light clock depends on the angle $\theta$, demonstrating how the effect of time dilation on the light clock is distributed in three dimensions within a moving frame.

When the time scaling factor of the light clock $\zeta_\theta = 0$, the time of the light clock in that $\theta$ direction is completely stationary. When $0 < \zeta_\theta < 1$, the time of the light clock in that $\theta$ direction slows down. When $\zeta_\theta = 1$, the time of the light clock in that $\theta$ direction is no relative change in time compared to the rest frame.

A noteworthy aspect of the light clock's operation arises when $\delta_\theta > 0$ and $\delta_{\pi-\theta} = 0$. In this scenario, light traveling along direction $\theta$ within the clock can propagate from one mirror to the other. However, the return path along $\pi - \theta$ becomes impossible. This effectively traps the light, preventing it from completing a full round trip (tick) within the clock. Consequently, the displayed time freezes, appearing to the rest frame observer as a completely static clock ($\zeta_\theta = 0$).

It's crucial to emphasize that this time stasis on the light clock does not contradict the ability of photons to propagate along $\theta$ when $\delta_\theta \neq 0$ within the moving frame. The halted clock reading signifies a standstill in the timekeeping mechanism, not the cessation of light propagation in all directions. Notably, in directions corresponding to $\delta_\theta \neq 0$, light propagation can be remains feasible.

According to Equation (6), the time dilation's effect varies when the light clock is placed at different angles $\theta$ along the direction of motion within the moving frame. To eliminate the variation in time dilation's effect caused by different $\theta$ angles in three-dimensional space inside the moving frame, and to ensure a comprehensive consideration of the time scaling factor of the light clock $\zeta_\theta$, we introduce a consensus time scaling factor of the light clock. This factor is determined by placing a light clock in each direction indicated by the uniformly distributed arrows from the origin to the external three-dimensional space, as illustrated in Figure 3. The mean value of the time scaling factors from all these light clocks is then taken to establish the consensus time scaling factor of the light clock, denoted as $\zeta$. This consensus time scaling factor of the light clock satisfies the following expression:

$$\zeta = \frac{\int_0^\pi \zeta_\theta \cdot \sin\theta d\theta}{\int_0^\pi \sin\theta d\theta} \tag{7}$$

By substituting formula (6) into formula (7), we obtain the expression for the consensus time scaling factor of the light clock $\zeta$ as follows:

$$\zeta = \frac{\left(1-\frac{v^2}{c^2}\right) \cdot \ln \frac{\left(s_v + \sqrt{s_v{}^2 - s_p{}^2 \cdot \left(1-\frac{v^2}{c^2}\right)}\right)^2}{s_p{}^2 \cdot \left(1-\frac{v^2}{c^2}\right)}}{2\sqrt{s_v{}^2 - s_p{}^2 \cdot \left(1-\frac{v^2}{c^2}\right)}} \tag{8}$$

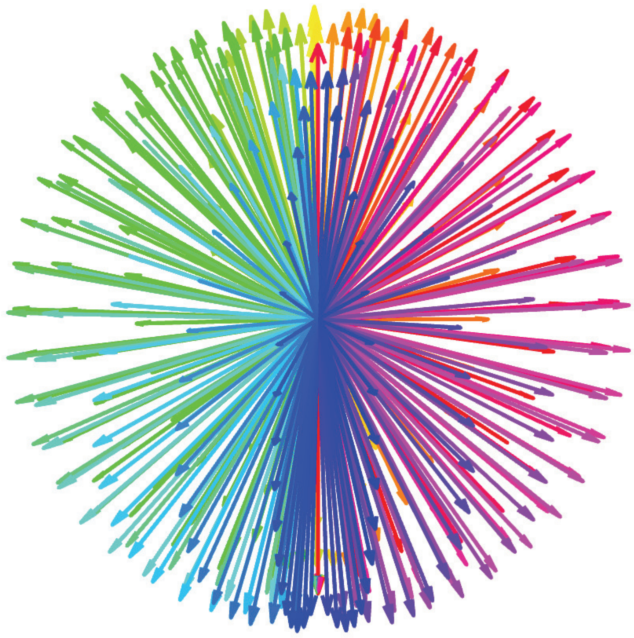

**Figure 3.** Illustration of the uniform distribution of vectors originating from the origin and extending outward in three-dimensional space.

where ${s_v}^2 - {s_p}^2 \cdot \left(1 - \frac{v^2}{c^2}\right) \geqslant 0$

The consensus time scaling factor of the light clock aligns with the principles of atomic clocks [10,11], which depend on the isotropic absorption and emission of photons during atomic vibrations. These vibrations occur uniformly in three dimensions, ensuring consistent and reliable timekeeping. Thus, applying a similar comprehensive consideration to the time scaling factor of the light clock in the three-dimensional space of a moving frame ensures more accurate and uniform time measurement, as supported by the three-dimensional isotropic properties fundamental to atomic clocks.

### *2.2. Compatibility of New Kinetic energy Formulae with Newtonian Mechanics at Low Velocities*

Given that Newton's kinetic energy equation[1] has been extensively validated at velocities much less than the speed of light and serves as a crucial foundation for analyzing the motion of objects at such velocities, any accurate and comprehensive kinetic energy equation proposed to replace Newton's kinetic energy equation must fulfil the condition that their approximate solutions at low velocities align with Newton's kinetic energy equation[12]. This ensures continuity and consistency in the understanding of motion laws across different velocity regimes.

According to Einstein's derivation based on the Lorentz factor in special relativity [4], the time scaling factor between the running time of the light clock within the moving frame and that of the light clock within the rest frame, denoted by $\eta$, satisfies the following expression:

$$\eta = \sqrt{1 - \left(\frac{v}{c}\right)^2} = \frac{1}{\gamma} \tag{9}$$

where $\gamma$ is the Lorentz factor.

In special relativity, the total energy ($E$) of an object with mass $m$ moving with velocity $v$ is given by:

$$E = \gamma mc^2 = \frac{mc^2}{\eta} \tag{10}$$

The rest energy ($E_0$) of the object (the energy when it is at rest) is:

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$$E_0 = mc^2 \tag{11}$$

The relativistic kinetic energy ($E_k$) is the total energy minus the rest energy:

$$E_k = E - E_0 = \gamma mc^2 - mc^2 = (\frac{1}{\eta} - 1)\frac{c^2}{v^2}mv^2 \tag{12}$$

Newton's classical kinetic energy formula ($E_{\text{Newton}}$) is:

$$E_{\text{Newton}} = \frac{1}{2}mv^2 \tag{13}$$

This formula is derived under the assumption that velocities are much smaller than the speed of light ($c$), which means:

$$\Phi(\eta) = \left(\frac{1}{\eta} - 1\right)\frac{c^2}{v^2} \tag{14}$$

$$\lim_{\frac{v}{c}\to 0}\Phi(\eta) = \frac{1}{2} \tag{15}$$

The formula (15) confirms that the relativistic kinetic energy reduces to the Newtonian form at low velocities, thereby ensuring consistency between the two theories. Consequently, any valid consensus time scaling factor of the light clock must satisfy this precondition to uphold Newton's kinetic energy equation at low velocities, as stated in the flowing equation (16). The formula (15) must still hold after replacing $\eta$ with $\zeta$:

$$\lim_{\frac{v}{c}\to 0}\Phi(\zeta) = \frac{1}{2} \tag{16}$$

The formula (8) can be solved by substituting it into Equation (16). After substituting formula (8) into formula (16), the expressions for $s_v$ and $s_p$ can be derived as follows:

$$s_v = \frac{(2\alpha+1)\,\beta - 1}{(2\alpha+1)\,\beta} + \frac{1}{(2\alpha+1)\,\beta}\cdot\left(1 - \frac{v^2}{c^2}\right)^{\frac{\beta}{2}} \tag{17}$$

$$s_p = {s_v}^{\alpha} \tag{18}$$

where $\alpha$ and $\beta$ are real numbers that satisfy the flowing conditions:

$$(2\alpha+1)\,\beta \neq 0 \tag{19}$$

$$\frac{(2\alpha+1)\,\beta - 1}{(2\alpha+1)\,\beta} + \frac{\left(1 - \frac{v^2}{c^2}\right)^{\frac{\beta}{2}}}{(2\alpha+1)\,\beta} - \left(1 - \frac{v^2}{c^2}\right)^{\frac{1}{2(1-\alpha)}} \geqslant 0 \tag{20}$$

All possible combinations of $\alpha$ and $\beta$ that satisfy the constraints outlined in equations (17)–(20) can be categorized as follows:

$$0 \leq \alpha < 1, \quad \text{with} \quad \beta \geq \frac{1}{2\alpha+1},$$

and

$$\alpha < -0.5, \quad \text{with} \quad \beta \neq 0.$$

**Table 1.** Categories of $(\alpha, \beta)$ combinations and their corresponding scaling effects.

| Category | Expression | Description |
|---|---|---|
| **I:** $\alpha = 0$ $\beta = 1$ | $s_v = \sqrt{1 - \frac{v^2}{c^2}} \in [0, 1]$ $s_p = (s_v)^0 = 1$ $\varepsilon = 0$ | Dimensions in the direction of velocity contract as the object moves, reducing to zero as $v$ approaches $c$, while dimensions perpendicular to the direction of velocity remain unchanged. |
| **II:** $\alpha = 0$ $1 < \beta \leq 1.7999999999$ | $s_v = \frac{(\beta-1)}{\beta} + \frac{1}{\beta}\left(1 - \frac{v^2}{c^2}\right)^{\beta/2} \in [\frac{(\beta-1)}{\beta}, 1]$ $s_p = (s_v)^0 = 1$ $\varepsilon \in (0, 10^{-17}]$ | Dimensions in the direction of velocity contract and reduce to $\frac{(\beta-1)}{\beta}$ as $v$ approaches $c$, while dimensions perpendicular to the direction of velocity remain unchanged. |
| **III:** $0 < \alpha \leq 3.333333 \times 10^{-10}$ $\beta = \frac{1}{2\alpha+1}$ | $s_v = \left(1 - \frac{v^2}{c^2}\right)^{\beta/2} \in [0, 1]$ $s_p = (s_v)^\alpha \in [0, 1]$ $\varepsilon \in (0, 10^{-17}]$ | Dimensions in both the direction of velocity and perpendicular to it reduce during motion, reaching zero as $v$ approaches $c$. |
| **IV:** $0 < \alpha \leq 3.333333 \times 10^{-10}$ $\frac{1}{2\alpha+1} < \beta \leq \beta^{\alpha}_{\varepsilon=10^{-17}}$ | $s_v = Eqs(17) \in \left[\frac{(2\alpha+1)\beta-1}{(2\alpha+1)\beta}, 1\right]$ $s_p = (s_v)^\alpha \in \left[\left(\frac{(2\alpha+1)\beta-1}{(2\alpha+1)\beta}\right)^\alpha, 1\right]$ $\varepsilon \in (0, 10^{-17}]$ | Dimensions in both the direction of velocity and perpendicular to it reduce, reaching $\frac{(2\alpha+1)\beta-1}{(2\alpha+1)\beta}$ and $\left(\frac{(2\alpha+1)\beta-1}{(2\alpha+1)\beta}\right)^\alpha$ respectively as $v$ approaches $c$. |

### *2.3. Compatibility to the Maximum Anisotropy in the Speed of Light Measured in the Michelson-Morley Experiment*

We further refine the potential range of valid factors by requiring that the maximum anisotropy of the speed of light, as derived from these factors, be consistent with current experimental results. According to the Michelson-Morley experiment, with the Earth revolving around the Sun at a velocity $v$ of 30 kilometers per second, the minimum measured value of the maximum anisotropy of the speed of light $\varepsilon$ on Earth is approximately $10^{-17}$, which means $\varepsilon \in [0, 10^{-17}]$. Under these conditions, we know that $\varepsilon$ satisfies the following expression:

$$\varepsilon = 1 - \frac{\zeta_{\theta=0}}{\zeta_{\theta=\pi/2}} = 1 - \left(\frac{(2\alpha+1)\beta - 1}{(2\alpha+1)\beta} + \frac{1}{(2\alpha+1)\beta}(1 - \frac{v^2}{c^2})^{\frac{\beta}{2}}\right)^{\alpha-1}(1 - \frac{v^2}{c^2})^{\frac{1}{2}} \tag{21}$$

In the scenario where $\beta = \frac{1}{2\alpha+1}$, the value of $\alpha$ can be determined using the following expression:

$$\alpha = \frac{ln(1-\varepsilon)}{3ln(1 - \frac{v^2}{c^2}) - 2ln(1-\varepsilon)} \tag{22}$$

Considering that the Earth orbits the Sun at a velocity of $v = 30$ kilometers per second and taking $\varepsilon \in [0, 10^{-17}]$, it is possible, according to equation (22), to determine that $\alpha \in [0, 3.3333333 \times 10^{-10}]$.

By substituting $\varepsilon = 10^{-17}$ and $v = 30$ kilometers per second into equation (21), the numerical solution for $\beta$, denoted as $\beta^{\alpha}_{\varepsilon=10^{-17}}$, is obtained. Specifically, when $\alpha = 0$, the solution yields $\beta^{\alpha=0}_{\varepsilon=10^{-17}} = 1.799999999999$.

Upon further analysis, considering that the maximum anisotropy of the speed of light predicted by this factor aligns with current experimental measurements, the previously identified range of $\alpha$ and $\beta$ values has been refined. The updated range is given by $(0 \leq \alpha \leq 3.333333333 \times 10^{-10}, \frac{1}{2\alpha+1} \leq \beta \leq \beta^{\alpha}_{\varepsilon=10^{-17}})$. Based on the distinct scaling effects, the combinations of $\alpha$ and $\beta$ are categorized into the four primary groups presented in Table 1.

## 3. Discussion

### *3.1. Visualization of the Scaling and Time Dilation Effect for Four Categories*

In order to intuitively visualize the scaling and time dilation effect corresponding to different combinations of $\alpha$ and $\beta$ in the six categories, we select one combination of $\alpha$ and $\beta$ values from each category for plotting. Specifically, we choose the following combinations:

- Category **I:** $(\alpha = 0, \beta = 1)$
- Category **II:** $\alpha = 0, \beta \in (1, 1.7999999999]$, we select $(\alpha = 0, \beta = 1.5)$

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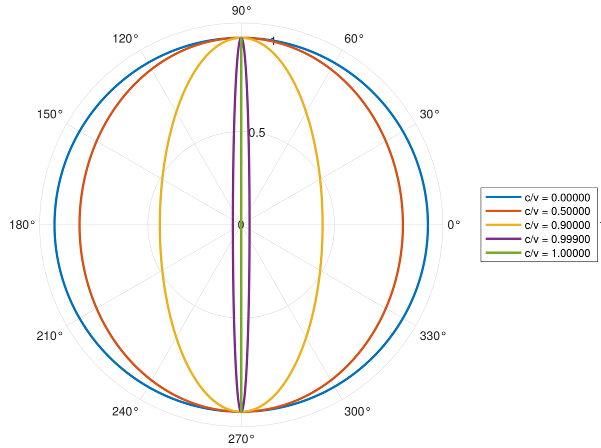
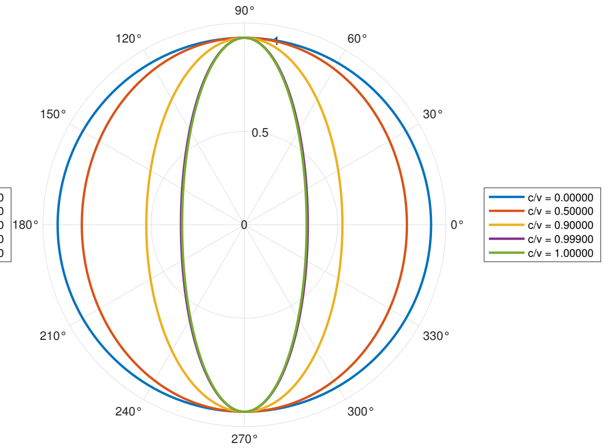
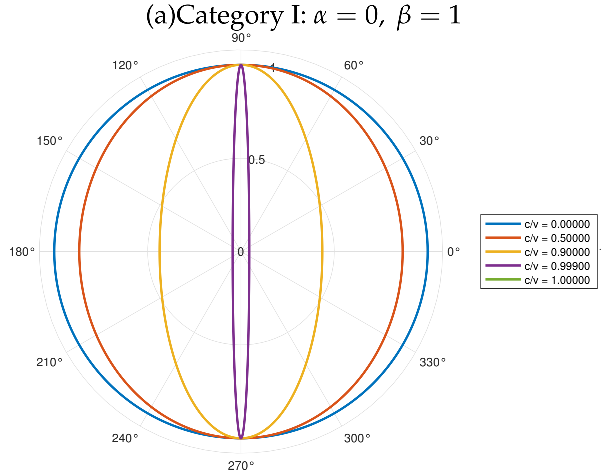
- **Category III:** $\alpha \in (0, 3.3333333 \times 10^{-10}], \beta = \frac{1}{2\alpha+1}$ , we choose $(\alpha = 2.0 \times 10^{-10}, \beta = \frac{1}{2\alpha+1})$
- **Category IV:** $\alpha \in (0, 3.3333333 \times 10^{-10}], \beta \in (\frac{1}{2\alpha+1}, \beta_{\varepsilon}^{\alpha}]$, we select $(\alpha = 2.0 \times 10^{-10}, \beta = 1.5)$



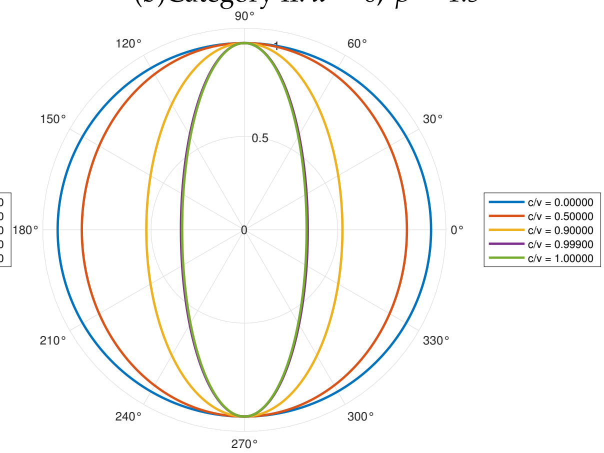

(a)Category I: $\alpha = 0,\ \beta = 1$




(b)Category II: $\alpha = 0,\ \beta = 1.5$

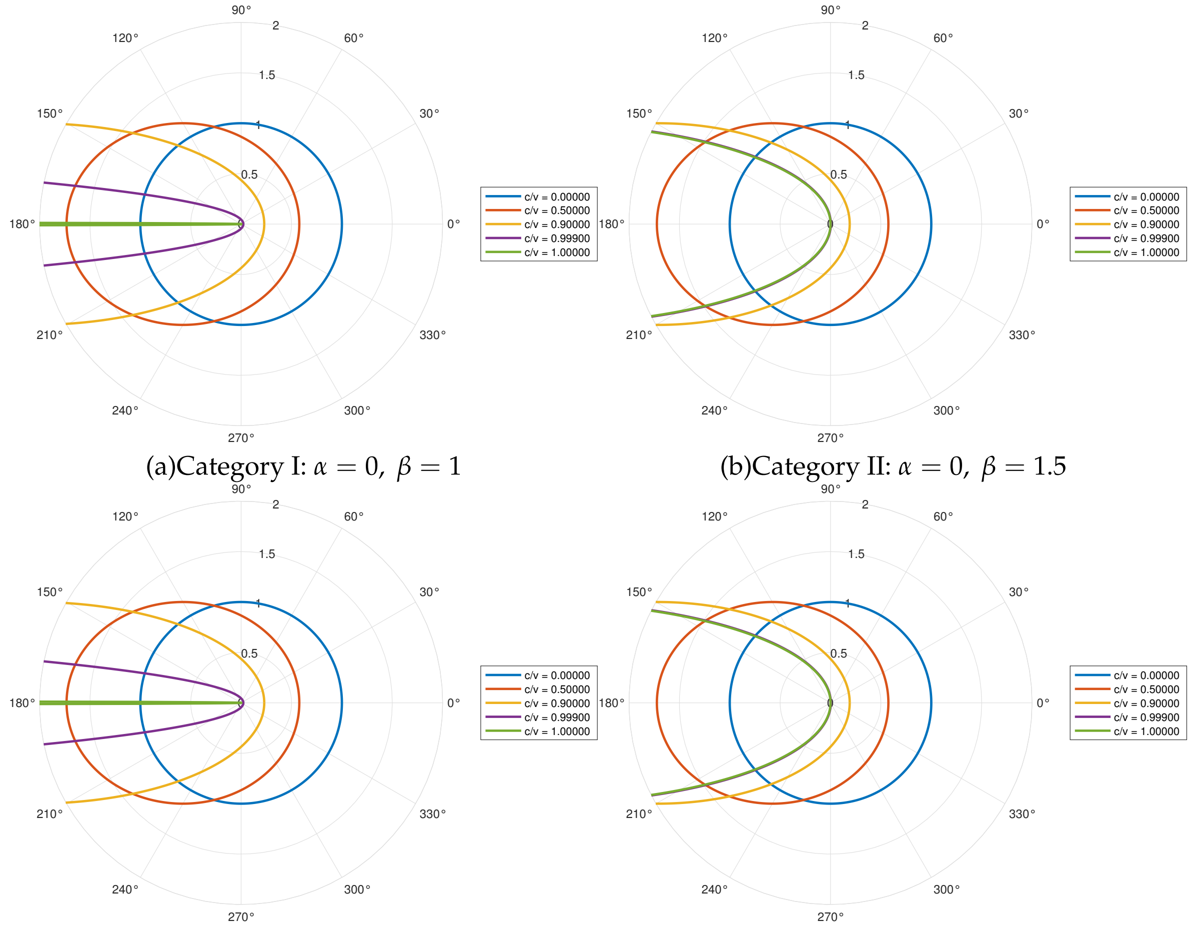



(c)Category III: $\alpha = 0.0000000002,\ \beta = \frac{1}{2\alpha+1}$




(d) Category IV: $\alpha = 0.0000000002,\ \beta = 1.5$

**Figure 4.** This visualization illustrates the scaling effect for four representative $(\alpha, \beta)$ combinations. Each diagram depicts the shape of a standard sphere with a radius of 1, initially at rest, and then moving at speeds of 0, 0.5, 0.9, 0.999, and 1.0 times the speed of light, as observed from a stationary reference frame under the influence of the scaling effect. The primary distinction between cases (a) and (c) is that as the speed approaches the speed of light, the size of (c) in the direction perpendicular to motion shrinks to zero, whereas in (a), it remains unchanged. Similarly, the key difference between cases (b) and (d) is that in (d), the size perpendicular to the direction of motion decreases slightly as the speed increases. In contrast, in (b), it remains constant, perpendicular to the motion.




(a)Category I: $\alpha = 0, \ \beta = 1$

(b)Category II: $\alpha = 0, \ \beta = 1.5$

(c)Category III: $\alpha = 0.0000000002, \ \beta = \frac{1}{2\alpha+1}$

(d) Category IV: $\alpha = 0.0000000002, \ \beta = 1.5$

**Figure 5.** Four representative $(\alpha, \beta)$ combinations are examined at speeds of 0, 0.5, 0.9, 0.999, and 1.0 times the speed of light to visualize the time dilation effect, $\delta_\theta$, in three dimensions as light rays travel at an angle $\theta$ relative to the direction of motion in a moving frame. Subfigures (a) and (c) are similar, with the key difference being that in (c), as the speed reaches the speed of light, $\delta_\theta$ remains non-zero for $\theta \in (\pi/2, \pi]$, whereas in (a), $\delta_\theta$ is non-zero only at $\theta = \pi$. Similarly, subfigures (b) and (d) both show non-zero $\delta_\theta$ values for $\theta \in (\pi/2, \pi]$.

The consensus time scaling factors $\zeta(\alpha, \beta)$ are visualized in Figure 6. The figure illustrates that the different $(\alpha, \beta)$ combinations of scaling factors exhibit a similar pattern: they all decrease as the speed of the object increases and approach zero as the speed nears the speed of light. The minimal differences between these factors suggest that even if the Lorentz factor is not the exact correct factor in nature, it closely approximates the true factor with an extremely small margin of error, effectively capturing the correct scaling effect.

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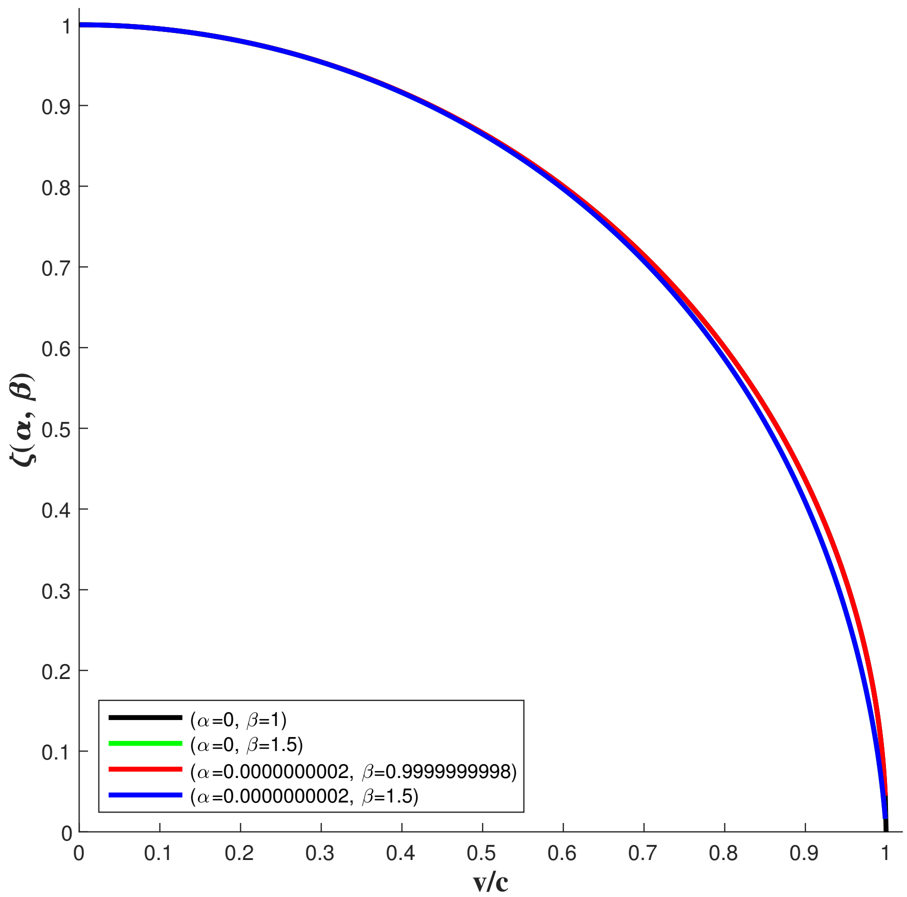


**Figure 6.** The consensus time scaling factors $\zeta$ for four representatives $(\alpha, \beta)$ combinations are visualized as the velocity of the moving object increases from 0 to $c$. In the figure, the black line representing Category 1 and the red line representing Category 3 overlap due to their minimal difference. Similarly, the green line representing Category 2 and the blue line representing Category 4 also overlap because the difference between them is negligible.

### *3.2. Analysis of Time Dilation Factor in Three Dimensions at Light Speed*

In special relativity, an object traveling at the speed of light is perceived by an external observer as experiencing no passage of time [13]. Initially, it was believed that photons, which travel at light speed, experience zero time regardless of their travel distance. However, observations show that photons undergo blueshift when near a massive object and redshift when farther away, indicating a change in their energy. Since this energy change occurs over time, the initial assumption that photons experience no time is incomplete.

To address this, we examine the relationship between $\delta_\theta$ and $\theta$ in three-dimensional space. Understanding this relationship is crucial for analyzing time dilation effects in this context.

Consider a hypothetical spaceship, with no rest mass, traveling at light speed. Inside the ship, a light source emits light at various angles $\theta$ relative to the ship's velocity. Observations from the rest frame show how these light rays behave. Table 2 illustrates whether the time experienced by light rays propagating at angle $\theta$ inside the spaceship is zero. The data indicate that, at light speed, all combinations of $(\alpha, \beta)$ result in non-zero $\delta_\theta$ values. Consequently, photons traveling in directions

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where $\delta_\theta \neq 0$ are not stationary and can eventually leave the spaceship, leading to an overall energy loss.

**Table 2.** Analysis of $\delta_\theta$ for four distinct $(\alpha, \beta)$ combinations when the object's speed equals the speed of light. Observed phenomena from a rest frame during unidirectional light travel along $\theta$.

| Category | Expression | Description |
|---|---|---|
| **I:** $\alpha = 0$ $\beta = 1$ | $\delta_\theta = 0$ when $0^\circ \leq \theta < 180^\circ$ $\delta_\theta = \infty$ when $\theta = 180^\circ$ | When the angle $\theta \in [0, 180^\circ)$, the travel time in this direction appears stationary to the observer in the rest frame. However, at $\theta = 180^\circ$, the travel time becomes non-stationary. |
| **II:** $\alpha = 0$ $1 < \beta \leq 1.7999999999$ | $\delta_\theta = 0$ when $0^\circ \leq \theta \leq 90^\circ$ $\delta_\theta \in (0, \frac{2\beta}{\beta-1}]$ when $90^\circ < \theta \leq 180^\circ$ | For $\theta \in [0, 90^\circ]$, the travel time appears stationary to the observer in the rest frame. For $\theta \in (90^\circ, 180^\circ]$, the travel time becomes non-stationary, increasing with the angle and reaching its maximum at $180^\circ$. |
| **III:** $0 < \alpha \leq 3.333333 \times 10^{-10}$ $\beta = \frac{1}{2\alpha+1}$ | $\delta_\theta = 0$ when $0^\circ \leq \theta \leq 90^\circ$ $\delta_\theta \in (0, \infty)$ when $90^\circ < \theta \leq 180^\circ$ | when $\theta \in [0, 90^\circ]$ , the travel time appears stationary. For $\theta \in (90^\circ, 180^\circ]$, the travel time becomes non-stationary and increases with the angle, peaking at $180^\circ$. |
| **IV:** $0 < \alpha \leq 3.333333 \times 10^{-10}$ $\frac{1}{2\alpha+1} < \beta \leq \beta^{\alpha}_{\varepsilon=10^{-17}}$ | $\delta_\theta = 0$ when $0^\circ \leq \theta \leq 90^\circ$ $\delta_\theta \in (0, \frac{2(2\alpha+1)\beta}{(2\alpha+1)\beta-1}]$ when $90^\circ < \theta \leq 180^\circ$ | For $\theta \in [0, 90^\circ]$, the travel time appears stationary. At angles $\theta \in (90^\circ, 180^\circ]$, the travel time becomes non-stationary, increasing with the angle and reaching its peak at $180^\circ$. |

Therefore, it is necessary to reconsider the distribution and passage of time for an object traveling at light speed in three-dimensional space. Additionally, the potential for photons' energy to diminish over time should be explored. Specifically, in the absence of external energy input, photons traveling in non-zero $\delta_\theta$ directions may experience a gradual decrease in their total energy.

### *3.3. Yuyunrui Factor*

To elucidate the potential physical laws that may underlie the observed small value of the maximum anisotropy of the speed of light in the Michelson-Morley Experiment, and to provide a clear comparison with the Lorentz factor, which assumes this anisotropy is zero, we introduce a new factor termed the Yuyunrui factor. This factor is proposed to account for any real values of anisotropy that might be obscured by the extremely small measurements obtained in the Michelson-Morley Experiment. The Yuyunrui factor incorporates two real variables, $\alpha$ and $\beta$, and is designed to satisfy two critical conditions: first, that the kinetic energy equation derived from this factor must approximate Newton's kinetic energy equation at low velocities, and second, that the maximum anisotropy of the speed of light derived from this factor must align with current experimental measurements of anisotropy. This framework aims to facilitate future investigations into the correct physical factor that accurately describes the observed phenomena.

The Yuyunrui factor, denoted by $\gamma_{yuyunrui}(\alpha, \beta)$, is defined as:

$$\gamma_{yuyunrui}(\alpha, \beta) = \frac{1}{\zeta(\alpha, \beta)} \tag{23}$$

Under the new Yuyunrui factor, the expressions for relativistic mass $m'$ and relativistic kinetic energy $(E_k)$ of an object moving at velocity $v$ are reformulated as follows:

$$m\prime = \gamma_{yuyunrui}(\alpha, \beta) m \tag{24}$$

$$E_k = E - E_0 = \gamma_{yuyunrui}(\alpha, \beta) mc^2 - mc^2 \tag{25}$$

The Lorentz factor is a special case of the Yuyunrui factor, specifically when $\alpha = 0$ and $\beta = 1$, and is represented as follows:

$$\gamma_{yuyunrui}(\alpha = 0, \beta = 1) = \gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{26}$$

## 4. Conclusions

The assumption that the maximum anisotropy of the speed of light is strictly zero is inconsistent with experimental observations. Although the measured anisotropy is very small, it should not be assumed to be zero. This small value is partly due to the limitations of the Michelson-Morley Experiment, which was conducted with the Earth orbiting the Sun at a velocity of only 30 kilometres per second, much slower than the speed of light. Future experiments conducted at higher velocities may reveal a different value for the maximum anisotropy, potentially increasing it. Therefore, the current measurements may not fully capture the maximum anisotropy of the speed of light. This suggests that the small observed anisotropy might indicate the existence of previously undiscovered physical laws. Any new theoretical factor must meet two criteria: it must reduce to Newton's kinetic energy equation at low speeds and align with the anisotropy measured in current experiments. To address these needs, we propose the Yuyunrui factor, which includes two hyperparameters, $\alpha$ and $\beta$. This factor encompasses all potentially valid factors, with the Lorentz factor being a special case where $(\alpha = 0, \beta = 1)$ and the maximum anisotropy is zero. We categorize combinations of $(\alpha, \beta)$ into four main groups based on their scaling effects and describe these effects in detail. Determining the correct values for $(\alpha, \beta)$ will require further rigorous experiments at higher speeds to accurately measure the maximum anisotropy of the speed of light.

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