

# World Quantum Theory: A Unified Framework for Quantum and Classical Physics Based on Frequency

## Abstract

This paper proposes the "World Quantum" as a fundamental unit of the physical world, whose intrinsic motion is based on the Planck frequency, forming the quantum foundation of space-time and energy. Within this framework, a generalized particle wavelength formula  $\lambda = xh/p$  is derived, where the projective coupling factor  $x$  reflects environmental modulation of quantum behavior. Momentum, mass, and total energy formulas are further established, and the "World Factor"  $\Phi_w = (c/v)^2$  is introduced to quantify the bending effect of external energy fields on the particle's trajectory. In this model, the de Broglie relation  $\lambda = h/p$  can be regarded as a resonant special case under terrestrial conditions with  $x = 2\pi$ . The total energy expression  $E_q = xhf_w\Phi_w$  unifies wave-particle duality with relativistic dynamics, offering a new perspective for the integration of classical and quantum physics, and proposes several experimentally testable schemes.

**Note:** The paper concludes with two detailed follow-up studies based on this framework: one on the fundamental nature of mass and momentum, and the other on the essential origin of voltage in Josephson junctions.

**Keywords:** World Quantum, Generalized Wavelength Formula, Projective Coupling Factor, World Factor, Frequency Model, Negative Feedback Mechanism

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## 1. Two Frequencies, One Light

Standard optics claims: " **When photons enter a medium from vacuum, frequency remains unchanged, wavelength shortens.**"

Yet no mechanism explains how wavefronts propagate between atoms—what carries the phase, and at what speed, through the vacuum gaps?

If transmission is instantaneous — causality is violated.

If delayed — frequency cannot stay constant.

This contradiction reveals a deeper flaw: treating light as a wave without a physical carrier.

We propose a resolution: frequency is not one, but two.

Light arises from the World Quantum — a fundamental entity with dual motion:

>**Internal Rotation at Planck frequency  $f_p$** : invariant, universal,

>**Macro-Rotation at frequency  $f_w$** : responsive to environment.

In a medium,  $f_w$  adjusts,  $\lambda$  changes accordingly — but  $f_p$  remains fixed, like  $c$  or  $G$ .

This is not a correction to quantum theory.

It's missing mechanism.

We ask only:

Can you draw the path of a photon's propagation?

If not — your theory is formalism.

Ours is not.

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## 2. World Quantum

### 2.1 Natural Units and the Planck Scale

- **Planck frequency:** It is obtained as the reciprocal of Planck time  $tp = \sqrt{\frac{\hbar G}{c^5}}$

$$f_p = \frac{1}{tp} = \sqrt{\frac{c^5}{\hbar G}}$$

- **Planck Length:**

$$lp = \sqrt{\frac{\hbar G}{c^3}}$$

- **Planck Mass:**

$$mp = \sqrt{\frac{\hbar c}{G}}$$

### 2.2 Parametric Analysis of Internal Rotation

Further, from the relationships among Planck units, we derive two fundamental identities:

**Relation 1:**

$$l_p \cdot f_p = \sqrt{\frac{\hbar G}{c^3}} \cdot \sqrt{\frac{c^5}{\hbar G}} = c$$

This formula shows that the product of Planck length and Planck frequency equals the speed of light,  $c$ .

**Relation 2:**

$$m_p \cdot l_p^2 \cdot f_p = \sqrt{\frac{\hbar c}{G}} \cdot \left( \sqrt{\frac{\hbar G}{c^3}} \right)^2 \cdot \sqrt{\frac{c^5}{\hbar G}} = \hbar$$

This formula shows that the product of Planck mass, the square of Planck length, and Planck frequency equals the reduced Planck constant,  $\hbar$ .

### 2.3 Definition and Properties of the World Quantum

In this paper, the World Quantum is defined as the smallest dynamical unit composing the physical world.

This unit is a self-sustained, periodic dynamical process at the Planck scale, whose total energy is identically  $E_p = m_p c^2$ , where  $m_p$  is the Planck mass.

The spatial scale of its trajectory is the Planck length  $l_p$ , such that the circumference of its closed path equals  $l_p$ ;

The temporal scale is the Planck time  $t_p$ , with an oscillation frequency  $f_p = 1/t_p$  ;

Consequently, its trajectory speed is always equal to the speed of light:  $v = l_p \cdot f_p = c$ . Here, “**trajectory speed**” does not refer to the conventional tangential velocity in circular motion, but rather to the actual instantaneous speed along its closed dynamical path—the true geometric speed of the World Quantum’s periodic motion.

**(Note: According to relativity, time is subject to dilation. In this work, all temporal measurements are constructed upon  $t_p$  as the fundamental, indivisible unit, forming the descriptive framework for elementary motion.)**

## 2.4 Internal Rotation and Macro-Rotation: Two Levels of Motion

### Internal Rotation:

The minimal dynamical unit described above — the World Quantum — is also referred to as Internal Rotation.

Internal Rotation is the intrinsic property of the World Quantum, serving as the dynamic foundation upon which the physical world is built. It is independent of external conditions and cannot be further decomposed. It is introduced here as a priori postulate of the theory.

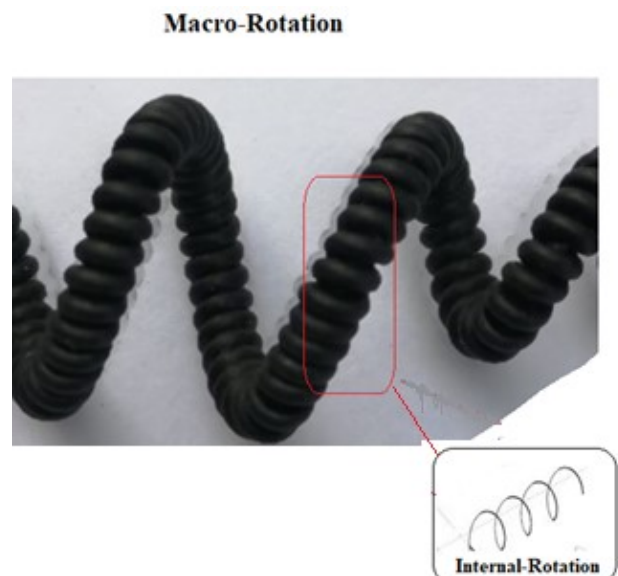
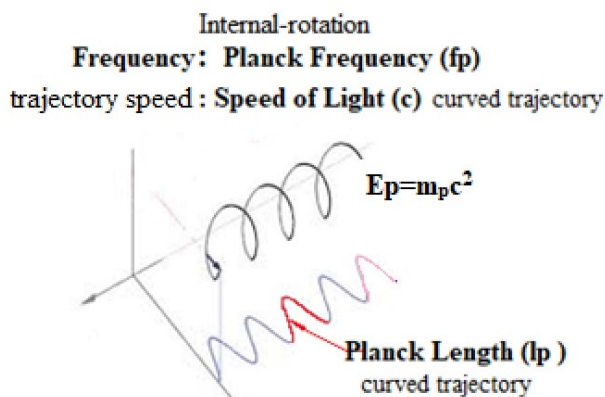
### Macro-Rotation:

When a World Quantum is embedded in an external energy field or complex interactions, its motion evolves into a more complex, macroscopic periodic behavior, termed macro-rotation (or "macro-rotation" for short).

Macro-rotation gives rise to observable physical quantities, determining:

- >the effective mass of particles,
- >the distribution of energy,
- >the scales of length and space,
- >the apparent flow of time,
- >and the unified expression of wave-particle duality.

### Illustration of Internal and Macro-Rotation:



## Clarification on Internal Rotation:

The concept of Internal Rotation is introduced as a foundational assumption, analogous to the gravitational constant  $G$  in classical mechanics. Its role is to coherently link physical quantities at the Planck scale, ensuring self-consistency within the unified framework. This paper does not attempt to analyze or experimentally verify the mechanism behind Internal Rotation itself. We acknowledge: we do not know why Internal Rotation exists in this form. We welcome skepticism and challenge regarding this postulate — indeed, that is our intention. Scientific progress begins with questioning fundamental assumptions. However, we caution against elevating "Internal Rotation" to a dogma or mystical principle. As Einstein said, “God does not play dice.” We believe the deep order of nature is comprehensible, not arbitrary. The empirical validation of this theory focuses primarily on macro-rotation. Its observable predictions — such as energy structure and velocity dependence — constitute the testable core of the framework.

## 2.5 Mechanistic Interpretation of the Photon Energy Formula $E=hf$

In quantum mechanics, the classical photon energy formula is:

$$E = hf$$

By combining the relationship between the reduced Planck constant  $\hbar$  and the Planck constant  $h$ ,  $\hbar = \frac{h}{2\pi}$ , it can be further expressed as:

$$E = 2\pi\hbar f$$

Since  $mp \cdot lp^2 \cdot f_p = \hbar$ , we obtain:

$$E = 2\pi \cdot mp \cdot lp^2 \cdot f_p \cdot f$$

Assuming a circular trajectory for the Internal rotation, we define its radius  $r$  via the Planck length as the circumference:

$$lp = 2\pi r$$

Substituting  $lp = 2\pi r$  into  $E = 2\pi \cdot mp \cdot lp^2 \cdot f_p \cdot f$ , we get the following formula:

$$E = 2\pi \cdot mp \cdot (2\pi r)^2 \cdot f_p \cdot f$$

Rearranging, we obtain:

$$E = (2\pi) \cdot mp \cdot r^2 \cdot 2\pi f_p \cdot 2\pi f$$

### Understanding the Parameters in the Formula:

- **(2π)**: Projection coupling factor — a dimensionless parameter characterizing the efficiency of dynamical matching between Internal and macro-rotation. Its value depends on the local physical environment (e.g., gravitational field, electromagnetic background, vacuum fluctuations), with detailed mechanisms to be elaborated in Section 3.2.
- **E**: Total energy of the World Quantum (in joules).
- **mp · r<sup>2</sup>**: Moment of inertia of the World Quantum during Internal Rotation.
- **2 π fp**: Angular velocity of Internal Rotation.
- **2πf**: Angular velocity of macro-rotation.
- **(2πf p)(2πf)**: Coupling between Internal and macro-rotational angular velocities.

### Summary

The formula  $E = 2\pi \cdot mp \cdot r^2 \cdot 2\pi f_p \cdot 2\pi f$  further validates the dual nature of the World Quantum — possessing both Internal Rotation and macro-rotation — and highlights the constancy of Internal Rotation. This demonstrates the internal logical consistency of our description.

In the next section (Section 3), we will build upon the constancy of Internal Rotation frequency  $f_p$  to define the three parameters of macro-rotation, and derive their relationships with observable physical quantities in our universe.

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## 3. The Derivation of the Total Energy Formula of the World Quantum

This paper proposes that the World Quantum, under the influence of different energy fields in the physical world (such as gravitational fields, Higgs fields, Yang-Mills fields, electromagnetic fields, and artificial energy fields), forms macroscopic wave combinations of different frequencies, thereby manifesting as macroscopic phenomena of fundamental particles, such as photons and quarks. For particles formed by the Macro-Rotation waves of the World Quantum, their Macro-Rotation frequency has a fixed value at every point in time, and this fixed value corresponds to other physical properties of the particle, such as total energy, mass, and momentum. Based on this consideration, this paper provides a

frequency-based theoretical framework to unify the description of a particle's momentum, mass, and energy properties.

It is particularly important to note that the Internal-Rotation parameters of the World Quantum are already encapsulated in Planck's constant  $h$ . Therefore, unless explicitly stated otherwise, all dynamic descriptions of the World Quantum in this section specifically refer to its Macro-Rotation properties.

### **3.1 Quantification and Definition of the Macro-Rotation Parameters of the World Quantum**

#### **3.1.1 Definitions of Particle Wavelength, Frequency, and Wave Speed Formed by the World Quantum**

- **Particle Wavelength**
  - The arc length in 3D space actually traveled by the World Quantum's equivalent trajectory point during one Macro-Rotation period, as it manifests a given observable particle state via intrinsic rotation.
  - Symbol:  $\lambda$
  - Unit: meters (m)
- **Particle Frequency**
  - The number of periodic oscillations occurring in one unit of time during the Macro-Rotation of the World Quantum.
  - Symbol:  $f_w$
  - Unit: hertz (Hz)
- **Particle Wave Speed**
  - The curved path distance traveled by the World Quantum in one unit of time during Macro-Rotation.
  - Symbol:  $v$
  - Unit: meters per second (m/s)

In this paper, the actual motion path of the World Quantum's, influenced by energy fields, is generally a curved trajectory. Therefore, the particle wave speed  $v$  and wavelength  $\lambda$ , as defined by the World Quantum, are based on its curved path. This differs from the traditional definition of straight-line trajectories. Compared to traditional theories, this redefinition more accurately reflects the influence of external energy fields on the Macro-Rotation behavior of the World Quantum.

### **3.2 Generalized Particle Wavelength Formula: $\lambda = \frac{x \cdot h}{p}$**

#### **3.2.1 Physical Definition of Macro-Rotation Angular Momentum: A Topological-Geometric Conserved Quantity**

This paper proposes that when the World Quantum moves under external energy fields, its macroscopic trajectory (macro-rotation) carries an intrinsic conserved quantity—the **Macro-Rotation Angular Momentum**—defined as:

$$L_{\text{mac}} = \frac{1}{2\pi} \cdot \oint_{\Gamma} \mathbf{p} \cdot d\mathbf{s} \quad (1)$$

where:

$\Gamma$ : a closed path in space along which the World Quantum completes one full periodic motion;

$\mathbf{p}$ : the canonical momentum of the World Quantum;

$d\mathbf{s}$ : differential path element.

The integral  $\oint_{\Gamma} \mathbf{p} \cdot d\mathbf{s}$  is known as the **Momentum Circulation**, which serves as the geometric source of quantum phase.

### Physical Significance

$L_{\text{mac}}$  quantifies the "rotational strength" of one complete macroscopic cycle. It is not the classical angular momentum  $\mathbf{r} \times \mathbf{p}$ , but rather a **cycle-counting extraction of the action integral**, directly reflecting **phase coherence** in quantum systems.

### Mathematical Properties of $L_{\text{mac}}$

- 1. Topological Nature:** Depends only on whether the path  $\Gamma$  winds  $n$  times around a center, not on the detailed shape of the path;
- 2. Gauge Invariance:** If  $\mathbf{p} = \hbar \mathbf{k} + q\mathbf{A}$ , then  $\oint_{\Gamma} \mathbf{p} \cdot d\mathbf{s}$  includes  $q \oint_{\Gamma} \mathbf{A} \cdot d\mathbf{s}$  (Wilson loop), which is the physical basis of the Aharonov-Bohm effect and is **experimentally observable**;
- 3. Tendency toward Quantization:** In stable states,  $L_{\text{mac}}$  tends to take discrete values.

#### 3.2.2 The Internal -rotation to Macro-Rotation Angular Momentum Coupling Mechanism

We postulate that the macroscopic rotational behavior of the World Quantum is constrained and modulated by its **intrinsic rotational structure** (Internal -rotation). This constraint manifests as a **projective angular momentum coupling**:



$$L_{\text{mac}} = x \cdot L_p \quad (2)$$

where:

$L_p$ : the fundamental angular momentum unit associated with the Internal-rotation of the World Quantum;

$x$ : the **Projective Coupling Factor** (dimensionless), characterizing the "projection efficiency" of the Internal-rotation structure under local physical conditions;

The value of  $x$  depends on the local environment, such as electromagnetic fields, gravitational potential, and vacuum fluctuations.

#### Crucial Interpretation:

$x$  is **not a free fitting parameter**. It is a **vacuum response function**, analogous to the dielectric constant  $\epsilon$  or magnetic permeability  $\mu$ , but operating on the **quantum phase structure** of spacetime.

### 3.2.3 Definition of the Fundamental Internal -rotation Angular Momentum $L_p$

The Internal -rotation of the World Quantum is governed by universal scales:

Internal -rotation radius:  $r_p = \frac{l_p}{2\pi}$ , where  $l_p$  is the Planck length;

Tangential velocity:  $c$  (speed of light);

Mass:  $m_p$  (Planck mass).

Thus, its fundamental angular momentum is:

$$L_p = m_p \cdot c \cdot \left( \frac{l_p}{2\pi} \right) \quad (3)$$

Using the Planck unit relation  $m_p \cdot c \cdot l_p = \hbar$ , we substitute to obtain:

$$L_p = \frac{\hbar}{2\pi} \quad (4)$$

#### Physical Significance

$L_p = \frac{\hbar}{2\pi}$  represents the **elementary unit of intrinsic rotational**(Internal -rotation) **angular momentum** for the World Quantum—akin to the "atom of quantum rotation."

### 3.2.4 Derivation of the Generalized Particle Wavelength Formula

In macro-rotational motion, if the momentum magnitude  $p = |\mathbf{p}|$  is constant and the path is a closed periodic orbit, the momentum circulation simplifies to:

$$\oint_{\Gamma} \mathbf{p} \cdot d\mathbf{s} = p \lambda \quad (5)$$

where  $\lambda = \oint d\mathbf{s}$  is the path length over one cycle, i.e., the **macro-rotation wavelength**.

Substituting Eq. (5) into the definition (1):

$$L_{\text{mac}} = \frac{1}{2\pi} \cdot \oint_{\Gamma} \mathbf{p} \cdot d\mathbf{s} = \frac{p \lambda}{2\pi} \quad (6)$$

Now substitute the coupling hypothesis  $L_{\text{mac}} = X \cdot L_p$  and  $L_p = \frac{\hbar}{2\pi}$ :

$$\frac{p \lambda}{2\pi} = X \cdot \frac{\hbar}{2\pi} \quad \Rightarrow \quad \lambda = \frac{X \hbar}{p} \quad (7)$$

This is the **Generalized Particle Wavelength Formula**.

#### Notes on Clarity and Scientific Rigor

1. All symbols are clearly defined and consistent with standard physics notation.
2. The derivation is logically tight, moving from a **topologically robust definition** to a **testable prediction**.
3. The role of  $X$  is elevated from a parameter to a **dynamical vacuum response**, making it falsifiable.
4. The connection to observable phenomena (e.g., Aharonov-Bohm effect, SAA anomalies) is explicit.

### 3.2.5 Environmental Origin of the de Broglie Wavelength Formula

This paper further proposes that the **Planck constant  $\hbar$  is not a universally fundamental constant**, but rather an effective physical quantity derived from specific environmental conditions. The observed value  $\hbar = 2\pi \hbar$  arises from environmental modulation of the World Quantum's coupling behavior on Earth.

Specifically, Earth's gravitational field, electromagnetic background, and vacuum polarization effects collectively form a "**quantum medium**." Within this medium, the **Internal** and macro rotations of the World Quantum tend toward a stable resonant state, locking the projective coupling factor to:

$$x_{\oplus}=2\pi \tag{8}$$

Substituting  $x_{\oplus}=2\pi$  into the generalized wavelength formula (7):

$$\lambda = \frac{2\pi\hbar}{p} = \frac{h}{p} \tag{9}$$

This is the **de Broglie particle wavelength formula**.

Therefore, the de Broglie relation is not a universal law, but rather an **observational manifestation of the  $x=2\pi$  resonant state under Earth's environmental conditions**. Electrons, photons, and other particles exhibit  $\lambda=h/p$  in terrestrial laboratories precisely because they are all subject to the same environmental modulation of the coupling mechanism.

#### **Remark: Environmental Dependence of the Projective Coupling Factor**

This work emphasizes that  $x$  is a **dynamical parameter dependent on the environment**, whose value varies with the spacetime background. For example:

In deep crustal layers or strong gravitational fields, enhanced spacetime curvature may cause  $x$  to approach 1;

In deep space or low-background-field regions,  $x$  may exceed  $2\pi$ ;

In artificially engineered “flat vacuum” or anti-energy fields,  $x$  could be actively tuned, enabling intervention in quantum behavior.

Future experiments—such as high-precision interferometry, atomic clock comparisons, or deep-space quantum probing—could test for environmental drifts in  $x$ , providing empirical support for this theoretical framework.

**Postscript for the Reader:**The projection coupling factor  $x$ , while introduced in this work as a formal parameter, has exhibited potential environmental dependence in multiple independent observations—such as non-constant behavior observed in Earth-based laboratories, deep-space ranging, and galactic redshift data. We urge readers to carefully examine its logical self-consistency, and to promote systematic replication and cross-comparison of its behavior across diverse physical environments.

### **3.3 Relationship Between Physical Quantities of Particles Formed by the World Quantum**

This paper argues that particles formed by the World Quantum are also fundamental entities in the physical world. They exhibit both wave-like and particle-like properties. Therefore, the classical wave equation  $\lambda=v/f$  and the Generalized Particle Wavelength Formula

$\lambda = \frac{x \cdot \hbar}{p}$  are equally applicable to the quantification and correlation of their physical properties.

Based on the above arguments, the relationships between various physical quantities of particles formed by the World Quantum are derived as follows:

### 3.3.1 Wavelength-Frequency Relationship Based on the Classical Wave Equation

**From the classical wave equation  $\lambda = v/f$ , the relationship between the wavelength and frequency of particles formed by the World Quantum can be expressed as:**

$$\lambda = \frac{v}{f_w}$$

This formula describes the relationship between the particle wavelength  $\lambda$ , frequency  $f$ , and wave speed  $v$ .

Where:

- $\lambda$ : Particle wavelength
- $f_w$ : Particle frequency
- $v$ : Particle wave speed

### 3.3.2 Wavelength-Momentum Relationship Based on the Generalized Particle Wavelength Formula

**From the Generalized Particle Wavelength Formula  $\lambda = \frac{x \cdot \hbar}{p}$ , the relationship between the wavelength and momentum of particles formed by the World Quantum can be expressed as:**

$$\lambda = \frac{x \cdot \hbar}{p}$$

This formula describes the relationship between the particle wavelength  $\lambda$  and momentum  $p$ .

Where:

- $\lambda$ : Particle wavelength
- $\hbar$ : Reduced Planck constant
- $p$ : Particle momentum
- $x$ : the projective coupling factor

## 3.4 Derivation of the Momentum Formula for the World Quantum

This paper proposes that the wavelengths described by the Generalized Particle Wavelength Formula and the classical wave equation refer to the same property of particles formed by the World Quantum—specifically, the true curved path length of the Macro-Rotation. Therefore, these two equations can be combined to derive the particle momentum formula.

Starting from the wavelength formulas  $\lambda = \frac{x \cdot \hbar}{p}$  and  $\lambda = \frac{v}{f}$ , the following momentum formula can be derived:

$$p = \frac{x \cdot \hbar f_w}{v}$$

Where:

- $f_w$  : Particle frequency
- $p$ : Particle momentum
- $\hbar$ : Reduced Planck constant
- $v$ : Particle wave speed
- $x$ : **the projective coupling factor**

This formula indicates that the momentum of particles formed by the World Quantum is directly related to their frequency  $f_w$  and wave speed  $v$ . It highlights the crucial role of Macro-Rotation frequency in determining changes in particle momentum. At the same time, this formula establishes a quantitative connection between a particle's wave-like and particle-like properties, providing an important supplement to traditional theories.

### 3.5 Derivation of Mass Formula

Using the relativistic momentum formula  $p = \gamma m v$  and substituting  $p = \frac{x \cdot \hbar f_w}{v}$ , we derive:

$$m = \frac{p}{\gamma v} = \frac{\left( \frac{x \cdot \hbar f_w}{v} \right)}{\gamma v} = \frac{x \cdot \hbar f_w}{\gamma v^2}$$

Substituting the Lorentz factor  $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$ , we obtain:

$$m = \frac{x \cdot \hbar f_w}{\left( \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} v^2 \right)} = x \cdot \hbar f_w \sqrt{\frac{c^2 - v^2}{c^2 v^4}}$$

### 3.6 Derivation of Total Energy Formula

Combining the mass  $m$  and momentum  $p$  expressions with the relativistic total energy formula  $E_q = \sqrt{(pc)^2 + (mc^2)^2}$ , we derive:

$$E_q = \sqrt{\left(\frac{x \cdot \hbar f_w}{v} c\right)^2 + \left(x \cdot \hbar f_w \sqrt{\frac{c^2 - v^2}{c^2 v^4}} c^2\right)^2}$$

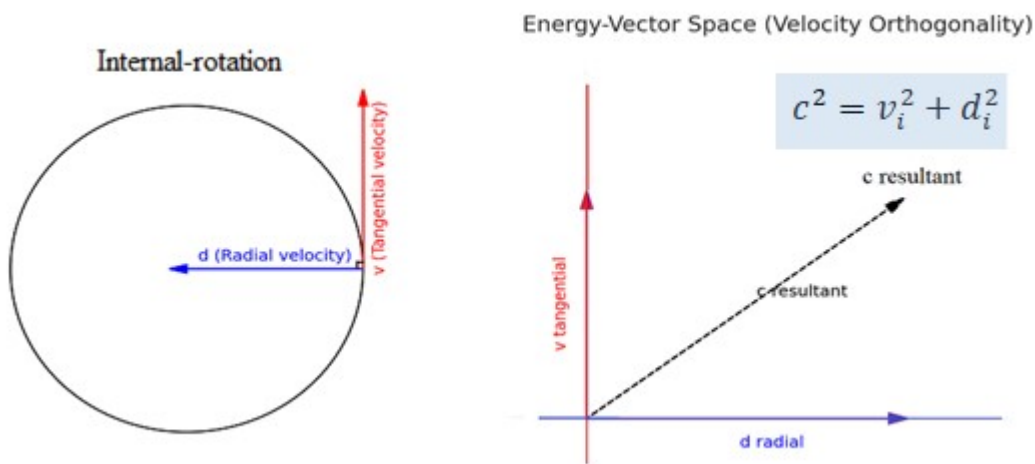
Simplifying yields:

$$E_q = x \cdot \hbar f_w \left(\frac{c}{v}\right)^2$$

Here,  $\Phi_w = \left(\frac{c}{v}\right)^2$  is defined as the **World Factor**, representing the extent of bending effects imposed by external energy fields on the path of World Quantum.

### 3.7 Physical Structure Analysis of the Total Energy Formula $E_q = x \cdot \hbar f_w \left(\frac{c}{v}\right)^2$

The Internal Rotation of the World Quantum consists of two strictly orthogonal internal velocity components:



Tangential velocity  $v_i$ : directed along the local tangent of the rotational path during the  $i$ -th Internal Rotation cycle;

Radial (compressive) velocity  $d_i$ : directed toward the center of the Internal Rotation structure in the i-th cycle.

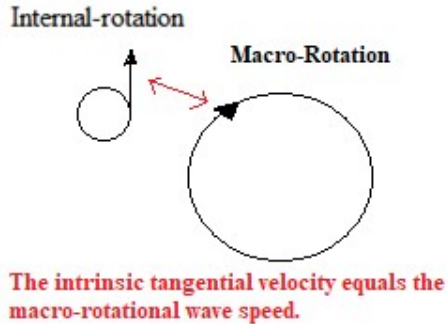
Within each Planck time  $t_p$ —which corresponds to one Internal Rotation period—these two components form the intrinsic velocity vector, whose magnitude is constantly the speed of light  $c$ , satisfying:

$$c^2 = v_i^2 + d_i^2 \quad (\text{for any } i)$$

In the formation of a macroscopic particle, a temporal average over  $N$  consecutive Internal Rotation events is required. We define:

the **Macro-rotational wave speed** :

$$v = \sqrt{\frac{1}{N} \sum_{i=1}^N v_i^2}$$



**NOTE:** Here, “Macro-rotational wave speed” refers to the effective tangential intensity that governs the phase propagation of the Internal Rotation sequence, quantified by the RMS value  $v$ .

The **Macro-rotational radial speed**:

$$d = \sqrt{\frac{1}{N} \sum_{i=1}^N d_i^2}$$

**NOTE:** Although the **Macro-rotational radial speed** produces no net displacement, its value determines the particle’s rest mass and serves as the intrinsic scalar origin of inertia.

Averaging the constraint over  $N$  events then yields the macroscopic relation:

$$c^2 = d^2 + v^2 \quad (1)$$

From the macro-rotation law  $p\lambda = x\hbar$  and the relativistic momentum expression  $p = \gamma mv$ , we obtain:

$$x \cdot \hbar = (\gamma mv) \lambda \quad \Rightarrow \quad m \lambda = \left( \frac{x}{\gamma v} \right) \hbar \quad (2)$$

Using the definition of the Lorentz factor  $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1}{\sqrt{\frac{c^2 - v^2}{c^2}}} = \frac{c}{d}$ , and substituting into

Eq. (2):

$$m \lambda = \left( \frac{x}{\gamma v} \right) \hbar = \left( \frac{x}{\left(\frac{c}{d}\right)v} \right) \hbar = x \cdot \frac{d}{cv} \hbar$$

Multiplying both sides by  $c$ :

$$mc \lambda = x \cdot \frac{d}{v} \cdot \hbar \quad (3)$$

Now multiply both sides of Eq. (3) by the macro-rotation frequency  $f_w$ :

$$mc \lambda f_w = x \cdot \frac{d}{v} \cdot \hbar f_w \quad (4)$$

Using the wave-speed relation  $v = \lambda \cdot f_w$ , we substitute  $\lambda \cdot f_w = v$  into Eq. (4):

$$mc v = x \cdot \frac{d}{v} \cdot \hbar f_w \quad \Rightarrow \quad m v^2 \cdot \frac{c}{d} = x \cdot \hbar f_w \quad (5)$$

Substituting  $\gamma = c/d$ :

$$\gamma \cdot m v^2 = x \cdot \hbar f_w \quad (6)$$

Multiplying both sides by  $(c/v)^2$ :

$$\gamma \cdot m c^2 = x \cdot \hbar f_w \left( \frac{c}{v} \right)^2 \quad (7)$$

Since  $E = \gamma m c^2$ , we arrive at the final result:



$$E_q = x \cdot \hbar f_w \left(\frac{c}{v}\right)^2$$

This derivation, based on velocity-space decomposition, reveals the geometric-dynamical structure of the total energy formula. The energy arises not only from the quantum action  $x\hbar$  and rotation frequency  $f_w$ , but is also modulated by the geometric amplification factor  $(c/v)^2$ , which quantifies the degree of path curvature induced by external energy fields.

### 3.9 Explanation of the Formula $E_q = x \cdot \hbar f_w \Phi_w$

#### 3.9.1 Negative Feedback Mechanism as $v \rightarrow c$

In this model, when the particle velocity  $v$  approaches the speed of light  $c$ , the World Factor  $\Phi_w = (c/v)^2 > 1$  increases gradually, tending to enhance the energy of the World Quantum. The total energy at this stage is given by:

$$E_q = x \cdot \hbar f_w \Phi_w$$

where  $x$  is the projective coupling factor, reflecting environmental modulation of quantum behavior. Crucially,  $x$  is not a constant, but a dynamic quantity dependent on the state of motion and external fields.

Consider the evolution during particle acceleration:

1. As momentum  $p$  increases, the generalized wavelength  $\lambda = x\hbar/p$  decreases;
2. A shorter wavelength implies enhanced spatial localization, driving the system into regions of stronger energy fields or higher spacetime curvature;
3. Under such conditions,  $x$  may decrease due to geometric constraints or field screening effects, thereby suppressing further energy growth.

Thus, in the limit  $v \rightarrow c$ , an intrinsic dynamic balance emerges:

4. On one hand,  $\Phi_w = (c/v)^2 \rightarrow (=f_p \text{ value})$ , driving  $E_q$  upward;
5. On the other hand,  $x \rightarrow 1$  (or saturates at a small value), counteracting the divergence of  $E_q$ .

This compensatory role of  $x$  against  $\Phi_w$  constitutes a natural negative feedback mechanism:

The closer the particle approaches  $c$ , the stronger the environmental modulation, leading to a reduction in its effective "quantum responsiveness," thereby limiting infinite energy accumulation.

This picture differs from the special relativistic assertion that "infinite energy is required to reach  $c$ ." The present model does not invalidate relativity, but offers a possible microscopic dynamical interpretation:

The apparent "infinite energy demand" may not be a true mathematical singularity, but rather a manifestation of significantly reduced  $x$ , degraded quantum coherence, and the breakdown of the macroscopic wave description at high energies.

Therefore, the  $v \rightarrow c$  limit is not a continuation of classical kinematics, but a critical regime where the quantum-geometric structure undergoes reconstruction, with the dynamics of  $x$  playing a key stabilizing role.

### 3.9.2 When $v=c$ : The Limiting State of Macro-Rotation

When the macro-rotational wave speed reaches  $v=c$ , the World Factor becomes  $\Phi_w=(c/v)^2=1$ . At this point, the total energy of a World Quantum simplifies to:

$$E_q = x \hbar f_w$$

This represents the maximum possible energy for a given intrinsic frequency  $f_w$  under unit world factor, as no additional enhancement from external energy fields or path curvature is present.

It is crucial to distinguish this state from the description of photons in standard quantum theory. In this model, even when  $v=c$ , the energy does not necessarily equal  $\hbar f$ , because:

>The fundamental quantum of action is  $\hbar$ , not  $h$ ;

>The coupling factor  $x$  encodes geometric and environmental projection effects, and generally  $x \neq 2\pi$ .

Now consider an extreme case: set  $v=c$ , normalize the intrinsic frequency to a unit value (e.g.,  $f_w=1$  in hertz), and let the coupling factor take the numerical value of the Planck frequency, denoted as  $(f_p \text{ value}) \approx 1.855 \times 10^{43}$ . Then the energy becomes:

$$E_q = (f_p \text{ value}) * \hbar * f_w = (f_p \text{ value}) * \hbar * 1(\text{Hz}) = E_p$$

where  $E_p$  is the Planck energy.

This is not a coincidence. It reflects a normalization-induced duality between two complementary limits of the same underlying entity:

>In the rest-mass limit ( $v=0$ ), the World Quantum is fully localized, with energy given by  $E=m_p c^2=E_p$ , corresponding to  $x=1$  and  $f_w=f_p$ ;

>In the pure-momentum limit ( $v=c$ ), the World Quantum is completely free and massless; if the frequency scale is normalized to unity ( $f_w=1$  Hz), the coupling factor must take the numerical value of  $f_p$  to compensate for the unit-scale mismatch, again yielding  $E_q=E_p$ .

These two limits—extreme localization versus extreme delocalization—are not contradictory, but rather two dual projections of the same Planck-scale entity. The identity

$$E_p = m_p c^2 = \hbar f_p$$

ensures energetic equivalence between the particle-like (mass-based) and wave-like (frequency-based) descriptions.

Thus,  $v=c$  does not merely describe a photon-like state, but represents the intrinsic limit of a World Quantum when environmental constraints vanish and internal rotation becomes completely free. In this regime, the value of  $x$  no longer reflects physical interaction strength, but rather serves as a numerical conversion factor between the observer's chosen frequency unit (e.g., hertz) and the natural Planck unit.

This duality reveals a deeper truth: the Planck energy is the fixed point at which the quantum-geometric system converges under both particle and wave extremes, unifying mass and motion in a single self-consistent framework.

### 3.9.3 When $v=0$ : The Rest Limit and the Breakdown of Description

Mathematically, as the macro-rotational wave speed  $v=0$ , the World Factor  $\Phi_w=(c/v)^2$  diverges. However, within the physical framework of this model, this divergence does not correspond to any actual physical quantity becoming infinite. Instead, it clearly signals the breakdown of the current theoretical description—marking the limit of its domain of validity.

The fundamental reason lies in the fact that when  $v=0$ , macro-rotation ceases entirely and wave-like behavior vanishes. At this point, the system no longer possesses a well-defined wavelength, phase, or interference properties—the “macroscopic wave picture” collapses completely. Energy is no longer distributed in a wave form but instead becomes fully localized within the Planck-scale internal structure of the World Quantum, manifesting as pure intrinsic rotation. In this limit, macro-rotation and intrinsic rotation effectively “unify” in a certain sense: all dynamical degrees of freedom contract back into the elementary unit itself, forming an extremely condensed, highly localized state.

It must be emphasized that the energy formula

$$E_q = x \cdot \hbar f_w \Phi_w$$

loses all physical meaning at  $v=0$ , because both the macroscopic frequency  $f_w$  and the wave speed  $v$  become undefined. Any attempt to apply this expression to the  $v=0$  case constitutes a misuse of the theory beyond its valid regime.

In this regime, the correct description of energy must switch to the rest-energy formula of special relativity:

$$E = \gamma mc^2 \quad (\text{with } \gamma=1 \text{ when } v=0, \text{ so } E=mc^2)$$

This “handover” between frameworks reveals a deep symmetry—and mutual limitation—between the two energy descriptions:

When  $v=0$ : the wave-based description fails, and we must rely on relativistic rest energy  $E=mc^2$ ;

When  $v=c$ : special relativity itself reaches its limit—since the rest mass  $m_0=0$ , it cannot account for the intrinsic structure of massless entities or their Planck-scale dynamics.

Thus:

The  $v=0$  limit marks the endpoint of wave description and the starting point of mass-based (relativistic) description;

The  $v=c$  limit marks the endpoint of mass-based description and the starting point of quantum-geometric description.

At these two extremes, both our wave-energy formula and the relativistic mass-energy relation expose the boundaries of their respective applicability. Neither alone suffices to describe the full behavior of World Quanta across all kinematic regimes—highlighting the need for a more fundamental theory that seamlessly bridges quantum geometry, relativity, and wave dynamics.

### 3.9.4 When $v>c$ : Apparent Superluminality and the Boundary of Description

In this model, if the macro-rotational wave speed exceeds  $c$ , the World Factor becomes  $\Phi_w=(c/v)^2<1$ , and the energy expression reads:

$$E_q = x \hbar f_w (c/v)^2$$

Here,  $E_q$  decreases as  $v$  increases, indicating a transition to a state of low energy density but high propagation speed. Crucially,  $v$  refers to the **wave speed of macro-rotation**, which may represent a **phase velocity** or the speed of a **non-local correlation**, rather than the local transfer of energy or information.

Therefore,  $v>c$  does not necessarily violate the principles of special relativity, but may correspond to one of the following physical scenarios:

#### 1. Apparent superluminal phenomena

In certain media or strong-field environments, the phase velocity of quantum waves can exceed  $c$  (analogous to Cherenkov radiation, where charged particles move faster than the phase speed of light in a medium). In such cases,  $v>c$  is an effective description that does not break causality.

#### 2. Cosmological recession velocities

In an expanding universe, distant galaxies recede from us at speeds exceeding  $c$ , not due to local motion, but due to the stretching of spacetime itself. Similarly, if the macro-rotation of World Quanta is modulated by cosmological evolution, its effective speed may exhibit  $v>c$  characteristics.

#### 3. Non-locality and hidden variable channels

If World Quanta constitute the fundamental structure of spacetime, their macro-rotation might enable rapid correlation through topological connections—such as quantum entanglement or ER bridges (Einstein-Rosen bridges). This "speed" is not classical motion, but an intrinsic synchronization mechanism among basic units. A value  $v>c$  then reflects the existence of **non-local dynamics**.

In such regimes, we may speculate that:

1. The projective coupling factor  $x$  could approach zero or even become complex, implying the breakdown of standard quantum measurement frameworks;
2. The physical scales defined by  $\hbar$ ,  $c$ , and  $G$  may no longer apply, requiring new parameters to describe this domain;
3. The conventional causal structure of spacetime might be restructured, entering a **"pre-geometric"** or **quantum network synchronization** phase.

It must be emphasized that this is **not a rejection of special relativity** in local inertial frames, but rather a proposal that:

Apparent superluminal behavior at  $v > c$  may reveal deeper quantum-structural dynamics beneath spacetime.

Thus, " $v > c$ " should not be seen as a challenge to existing theories, but as a **probe signal marking the boundary of current physical descriptions**—a hint that, under extreme non-locality or at cosmological scales, a new framework beyond "local fields + continuous spacetime" may be required.

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## 4. Experimental Design and Verification

### 4.1 Experiment One:

#### Challenging the Constancy of the Speed of Light in Vacuum: Testing the Influence of External Field Effects on Light Speed

##### Background

The constancy of the speed of light  $c$  in vacuum is a cornerstone of Einstein's special relativity. However, modern physics has increasingly shown that vacuum is not simply an "empty void" but a complex medium filled with quantum fluctuations and virtual particle pairs. In this context, the constancy of light speed may only be an approximation, particularly under extreme conditions or in the presence of external fields.

This experiment aims to test whether the speed of light  $v$  in vacuum is strictly equal to  $c$  or exhibits minor deviations, thus providing experimental validation for theoretical modifications proposed in this study.

##### Objectives

1. Verify whether the speed of light in vacuum is constant.
2. Measure the speed of light  $v$  under different conditions (e.g., varying gravitational field intensities, spatial locations) to detect any deviations.

3. If  $v < c$ , analyze the origin of the deviation and validate the modified theoretical formula:

$$, \Phi_w = \left(\frac{c}{v}\right)^2, \quad E_q = x \cdot \hbar f_w \Phi_w,$$

4. Provide experimental evidence to challenge the constancy of light speed hypothesis.

## Experimental Design and Methodology

### 1. Experimental Setup

- **High-Precision Light Speed Measurement Devices:**
  - Laser interferometer (nanometer-level resolution for detecting interference fringes caused by light speed variations).
  - Time-of-Flight (TOF) measurement devices for determining the time light travels over a precisely known distance.
- **Vacuum Chamber:**
  - Ultra-high vacuum chamber ( $\text{Pa} < 10^{-12}$ ) to minimize particle interference.
- **Adjustable Gravitational Environment:**
  - Simulating different gravitational environments (e.g., near Earth's surface, at varying altitudes, or using high-density masses to create localized gravitational fields).
- **Light Source:**
  - Monochromatic laser with high frequency stability ( $10^{-15}$ ).

### 2. Experimental Procedure

#### Step 1: Baseline Measurement of Light Speed in Standard Vacuum Conditions

- Measure the baseline value  $V_0$  the speed of light in an ultra-high vacuum using laser interferometry and TOF devices.
- Perform multiple independent measurements to account for experimental errors and ensure precision.

#### Step 2: Repeated Measurements Under Altered Conditions

- Conduct the experiment under the following altered conditions:
  - **Gravitational Field Variations:**
    - Measure light speed at different altitudes or near high-mass objects (e.g., dense metal spheres) to simulate different gravitational intensities.

- **Quantum Field Perturbations in Vacuum:**
  - Introduce varying strengths of electromagnetic fields or high-energy particle collisions within the vacuum chamber to stimulate quantum fluctuations.
- **Extreme Energy Conditions:**
  - Test the stability of light speed using high-energy photons (e.g., gamma rays).

### Step 3: Data Analysis

- Compare the measured light speed  $v$  under each condition with the baseline value  $V_0$
- Determine whether there is a systematic deviation  $\Delta V = V_0 - v$  and analyze whether the deviation matches predictions from the theoretical correction formula  $\Phi_w$ .

### Data Analysis

#### 1. Deviation Calculation:

$$\Delta V = V_0 - v$$

If  $\Delta v > 0$ , it indicates that the speed of light  $v$  is less than the theoretical constant  $c$ .

#### 2. Validation of the Correction Formula:

- Incorporate the deviation into the World Factor  $\Phi_w$  to compute the theoretical correction:

$$\Phi_w = \left(\frac{c}{v}\right)^2$$

- Compare experimental results with the predicted energy deviation:

$$E_q = x \cdot \hbar f_w \Phi_w$$

#### 3. Statistical Significance:

- Use statistical methods to ensure observed deviations are not attributable to experimental errors.

### Potential Outcomes

#### 1. If $v=c$ and no deviation is observed:

- The constancy of light speed hypothesis remains valid.
- The applicability of the modified energy formula  $E_q = x \cdot \hbar f_w \Phi_w$  to vacuum light speed may require further refinement.

**2. If  $v < c$  and a deviation is observed:**

- This challenges the constancy of light speed hypothesis.
- The deviation suggests that the propagation speed of light is influenced by external fields or vacuum microstructures.
- The theoretical framework, particularly the World Factor  $\Phi_w = \left(\frac{c}{v}\right)^2$  and the corrected energy formula, would gain strong experimental support.

## **Challenges and Solutions**

**1. Limitations in Measurement Precision:**

- Current light speed measurement techniques are highly precise but may need further refinement to detect minute deviations.
- Solution: Enhance TOF and interferometry techniques and utilize higher vacuum quality.

**2. Field Effects in the Vacuum Chamber:**

- Slight electromagnetic interferences in the vacuum chamber may affect measurements.
- Solution: Apply stringent shielding and conduct cross-verification using independent experimental setups.

## **Expected Impact**

**1. Scientific Significance:**

- If light speed is not constant, this would directly challenge the foundational assumption of special relativity.
- Results could strongly support a frequency-driven physical framework as proposed in this theory.

**2. Theoretical Advancement:**

- Validating deviations in light speed would introduce a new physical constant  $\Phi_w$ , redefining the energy formula for photons.
- This could provide a crucial bridge between classical and quantum physics.

**3. Future Research Directions:**

- Investigating the influence of vacuum microstructures on photon propagation.
- Extending the modified formula to other particles and conditions.

## **Summary**

Through this experimental design, it is possible to directly verify whether the photon propagation speed is less than the speed of light and whether the product of wavelength and frequency is less than the speed of light. This experiment not only supports the theoretical hypothesis but also provides new experimental evidence for the further development of physics. If successful, it will become an important milestone in unifying classical and quantum physics.



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## 5 . Acknowledgments

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## References

1. **Planck, M. (1900).** *On the law of distribution of energy in the normal spectrum.* Annalen der Physik, 4(553), 553–563.  
[Classic paper on Planck's law and the concept of quantum energy, setting the foundation for quantum theory.]
2. **Einstein, A. (1905).** *Does the inertia of a body depend upon its energy content?.* Annalen der Physik, 18(13), 639-641.  
[Einstein's famous energy-mass equivalence paper, central to understanding energy in relativistic systems.]
3. **Dirac, P. A. M. (1928).** *The quantum theory of the electron.* Proceedings of the Royal Society A, 117(778), 610-624.  
[A foundational paper on quantum theory, particularly the Dirac equation, essential for understanding particle physics.]
4. **Higgs, P. W. (1964).** *Broken symmetries and the masses of gauge bosons.* Physical Review Letters, 13(16), 508–509.  
[Introduction of the Higgs mechanism, which is crucial for your discussion of mass and the Higgs field.]
5. **Feynman, R. P., Leighton, R. B., & Sands, M. (1963).** *The Feynman Lectures on Physics*, Volume 1: *The New Millennium Edition*. Addison-Wesley.  
[A comprehensive and accessible resource on the foundational principles of quantum mechanics and classical physics.]
6. **Penrose, R. (2004).** *\*The Road to Reality*

Author: Ji Bo Yang\Qwen\chatGPT

Email: [1264855386@qq.com](mailto:1264855386@qq.com)

# The Essence of Rest Mass and Momentum: Orthogonal Decomposition of Energy Structure in World Quantum Theory

## Abstract

Within the framework of World Quantum Theory, this paper proposes that a particle's rest mass and momentum are not independent attributes, but rather projections of its intrinsic energy  $E_q$  onto two orthogonal directions: the radial component ( $d$ ) and the tangential component ( $v$ ). By substituting the relativistic total energy  $E_q = \gamma m_0 c^2$  into the orthogonal equation of World Quantum Theory, we derive:

$$E_m = \frac{d}{c} \cdot E_q \quad , \quad E_p = \frac{v}{c} \cdot E_q$$

where the geometric constraint  $c^2 = d^2 + v^2$  forms the foundation of the energy projection. This model naturally yields the relativistic energy-momentum relation  $E_q^2 = (pc)^2 + (mc^2)^2$ , and reveals that rest mass reflects the "degree of confinement" (radial oscillation) of energy within the environment, while momentum represents the "degree of motion" (tangential flow) of energy in spacetime. Together, they constitute the dual nature of particle existence.

**World Quantum Theory:** <https://zenodo.org/records/17092279>

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## 1. Introduction

In standard physical models, rest mass ( $m_0$ ) and momentum ( $p$ ) are treated as fundamental input parameters. However, in World Quantum Theory, particles are conceptualized as vibrational structures characterized by a macroscopic rotational frequency  $f_w$ . The total energy of a particle is given by:

$$E_q = x \cdot \hbar f_w \left( \frac{c}{v} \right)^2$$

where

$x$  is the projective coupling factor,

$\hbar$  is the reduced Planck constant, and

$\Phi_w = (c/v)^2$  is the world factor, quantifying the influence of external energy fields on the particle's trajectory.

This paper aims to demonstrate that:

Rest mass ( $m_0$ ) is not an intrinsic property, but a manifestation of the particle's degree of radial confinement within different environments.

Momentum ( $p$ ) is also not an intrinsic property, but a manifestation of the particle's degree of tangential motion within different environments.

We propose a core hypothesis: the speed of light  $c$  can be decomposed into two orthogonal components:

d: Macro-rotational radial speed, representing the degree of confinement within the environment,

v: Macro-rotational wave speed, corresponding to the degree of motion within the environment, satisfying the geometric relation:

$$c^2 = d^2 + v^2 \quad (1)$$

This relation serves as the cornerstone for all subsequent derivations.

## 2. The Nature of Rest Mass: $E_m = \frac{d}{c} \cdot E_q$

### 2.1 Orthogonal Decomposition of World Quantum Energy

Based on the vibrational structure of the World Quantum, the total energy, modulated by tangential velocity, is orthogonally decomposed into contributions along the "radial" and "tangential" directions:

$$E_q \cdot v^2 = x \cdot \hbar \cdot f_w \cdot v^2 + x \cdot \hbar \cdot f_w \cdot d^2 \quad (2)$$

This equation indicates that the energy term  $E_q \cdot v^2$  is apportioned into contributions associated with tangential motion ( $v^2$ ) and radial confinement ( $d^2$ ).

### 2.2 Substitution of Relativistic Total Energy

The relativistic total energy is given by:

$$E_q = \gamma m_0 c^2 \quad , \quad \gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (3)$$

Substituting into Equation (2), we obtain:

$$(\gamma m_0 c^2) v^2 = x \cdot \hbar f_w (v^2 + d^2) \quad (4)$$

### 2.3 Application of the Geometric Constraint

Using the relation  $c^2 = d^2 + v^2$  from Equation (1), we substitute  $d^2 + v^2 = c^2$  into Equation (4):

$$(\gamma m_0 c^2) v^2 = x \cdot \hbar f_w c^2 \quad ==> \quad \gamma m_0 v^2 = x \cdot \hbar f_w \quad (5)$$

This equation establishes a direct connection between the relativistic momentum term  $p = \gamma m_0 v$  and the World Quantum parameters  $x \cdot \hbar f_w$

### 2.4 Derivation of Rest Mass Energy

Define the rest mass energy as:

$$E_m = m_0 c^2$$

From Equation (3), the total energy is:

$$E_q = \gamma m_0 c^2 = \gamma E_m$$

Using the geometric constraint  $d = \sqrt{c^2 - v^2}$ , the Lorentz factor becomes:

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1}{\sqrt{\frac{c^2 - v^2}{c^2}}} = \frac{c}{d} \quad (6)$$

Substituting into  $E_q = \gamma E_m$ , we obtain:

$$E_q = \frac{c}{d} E_m \implies E_m = \frac{d}{c} E_q \quad (7)$$

### 2.5 Physical Interpretation

Equation (7) indicates that the rest mass energy  $E_m$  is the projection of the total energy  $E_q$  along the "radial" direction. The ratio  $\frac{d}{c}$  represents the "degree of confinement" within the environment. Key limiting cases include:

When  $d \rightarrow c$  (i.e.,  $v \rightarrow 0$ ),  $E_m \rightarrow E_q$ , corresponding to a stationary particle with maximum rest mass energy.

When  $d \rightarrow 0$  (i.e.,  $v \rightarrow c$ ),  $E_m \rightarrow 0$ , as in the case of massless particles like photons.

Thus, rest mass reflects the extent to which the particle is confined within the environment, i.e., the intensity of its radial oscillation.

## 3. The Nature of Momentum: $E_p = \frac{v}{c} \cdot E_q$

### 3.1 Definition of Momentum Energy

To maintain symmetry with rest mass energy, we define momentum energy as:

$$E_q = pc \quad (8)$$

which has dimensions of energy and forms an orthogonal pair with  $E_m$

### 3.2 Relativistic Momentum

The relativistic momentum is:

$$p = \gamma m_0 v \quad (9)$$

Thus:

$$E_p = p c = \gamma m_0 v c = \gamma m_0 c v \quad (10)$$

### 3.3 Calculation of Momentum Energy Projection

Using the total energy  $E_q = \gamma m_0 c^2$ , we compute:

$$\frac{v}{c} \cdot E_q = \frac{v}{c} \cdot (\gamma m_0 c^2) = \gamma m_0 c v \quad (11)$$

### 3.4 Result

Comparing Equations (10) and (11), we find:

$$E_p = \gamma m_0 c v = \frac{v}{c} \cdot E_q \quad (12)$$

### 3.5 Physical Interpretation

Equation (12) indicates that the momentum energy  $E_p$  is the projection of the total energy  $E_q$  along the "tangential" direction. The ratio  $\frac{v}{c}$  quantifies the "degree of motion" in spacetime. Key limiting cases include:

When  $v \rightarrow c$ ,  $E_p \rightarrow E_q$ , indicating that all energy contributes to motion, as in the case of photons.

When  $v \rightarrow 0$ ,  $E_p \rightarrow 0$ , with all energy confined to the rest mass.

Thus, momentum reflects the degree of motion within the environment, i.e., the intensity of its tangential flow.

#### 4. Unified Framework: Symmetry of Radial and Tangential Components

Squaring and summing Equations (7) and (12):

$$E_m^2 + E_p^2 = \left( \frac{d^2}{c^2} + \frac{v^2}{c^2} \right) E_q^2 = \left( \frac{d^2 + v^2}{c^2} \right) E_q^2 = E_q^2 \quad (13)$$

since  $d^2 + v^2 = c^2$ . Substituting  $E_m = m_0 c^2$  and  $E_q = pc$ , we obtain:

$$E_q^2 = (pc)^2 + (m_0 c^2)^2 \quad (14)$$

This naturally reproduces the relativistic energy-momentum relation without additional assumptions.

#### 5. Conclusion

This paper demonstrates that within the framework of World Quantum Theory:

Rest mass ( $m_0$ ) is not a measure of material substance, but a manifestation of the radial velocity of energy within the environment, given by  $E_m = \frac{d}{c} \cdot E_q$ .

Momentum ( $p$ ) is not merely a measure of motion, but a manifestation of the tangential velocity of energy within the environment, given by  $E_p = \frac{v}{c} \cdot E_q$ .

The orthogonal decomposition  $c^2 = d^2 + v^2$  provides the geometric foundation for these projections.

The relativistic energy-momentum relation emerges as a direct consequence of this framework.

A particle is not a point,

it is—

a vibrational knot,

eternally oscillating

between "radial confinement" and "tangential motion".

This perspective offers a novel geometric-vibrational interpretation of mass, inertia, and potentially gravity.

Author: Ji Bo Yang

Email: [1264855386@qq.com](mailto:1264855386@qq.com)

#### Appendix A: Reinterpreting the Misconception of Time Dilation from the Essence of the Lorentz Factor

————— $\gamma = c/d$  — Time Dilation is a Mismatch of Timekeeping Bases

For a century, people have said: "Motion slows time."

This is a misconception.

The truth is:

Time does not change. What changes is the "clock".

### **1. The Essence of the Lorentz Factor: $\gamma = c/d$**

In World Quantum Theory, the Lorentz factor  $\gamma$  is not abstract mathematics.

It is the ratio of the speed of light to the Macro-rotational radial speed component  $d$  of a particle's energy within its environment:

$$\gamma = \frac{c}{d}$$

The larger  $d$ : energy is more "confined", the particle is more "at rest",  $\gamma \rightarrow 1$ .

The smaller  $d$ : energy is more "flowing", the particle is more "in motion",  $\gamma \rightarrow \infty$ .

$\gamma$  is not a function of time,

but a geometric ratio of energy projection.

### **2. The Truth of Time Dilation: A Mismatch in Timekeeping Bases**

How do we measure time?

With periodic processes—such as the oscillation frequency  $f_w$  of a particle.

But in World Quantum Theory,  $f_w$  is not fixed.

It depends on the particle's environment:

Strength of gravitational fields,

State of motion,

Vacuum fluctuations...

When a particle moves, its Macro-rotational radial speed  $d$  changes  $\rightarrow \gamma=c/d$  changes  $\rightarrow f_w$  changes.

Result:

The "smallest time unit" (i.e.,  $1/f_w$ ) differs across environments.

You time things using  $f_w^{(1)}$  in your environment,

I use  $f_w^{(2)}$  in mine.

When we observe each other,

we conclude: "Your time has slowed down."

This is not time itself dilating.

It is a mismatch in timekeeping standards,

like two people using rulers with different scales,

each claiming: "In your place, one meter has become longer."

Conclusion

The term "time dilation" has misled the world for a century.

It suggests time is a stretchable substance.

The truth is:

There is no "slowing of time",  
only the "clock" has changed.

When  $\gamma=c/d$  changes,  
it is the intrinsic frequency  $f_w$  of the timekeeping particle that changes,  
it is the measurement standard that drifts.

**Science is,**

**observe reality as it is,**

**think truthfully.**

Author: Ji Bo Yang

Email: [1264855386@qq.com](mailto:1264855386@qq.com)

## **The Ontological Voltage in Josephson Junctions: A Manifestation of Macro-Rotational Quantum State**

Abstract

We propose that the voltage  $U$  observed in a Josephson junction is not an externally applied driving parameter, but the ontological equivalent voltage of the Cooper pair's macro-rotational quantum state. Based on the World Quantum model  $E_q = x \cdot \hbar f_w \left(\frac{c}{v}\right)^2$ , we rigorously derive:

$$f_w = K_j U \left(\frac{v}{c}\right)^2$$

This establishes a direct ontological identity between voltage  $U$  and quantum state energy  $E_q$ . From this, we obtain a new expression for the Josephson frequency:

$$f_w = K_j U \left(\frac{v}{c}\right)^2$$

where  $(v/c)^2$  reflects the quantum response efficiency of the vacuum structure. This result connects macroscopic superconductivity with the ontological unification of energy and voltage, revealing the dependence of quantum frequency on carrier dynamics.

## 1. Introduction

The Josephson effect is a cornerstone of quantum metrology, and its frequency-voltage relation  $f = K_J U$ , ( $K_J = 2e/h$ ) is widely used to define voltage standards. However, this relation assumes instantaneous phase evolution, ignoring the physical reality that carriers (Cooper pairs) move at finite velocity  $v$ .

We propose:

**Voltage  $U$  is not "applied" to the Cooper pair—it is "read out" from its quantum state.**

As a "World Quantum," the Cooper pair possesses intrinsic energy  $E_q$ . The voltage  $U$  is the normalized expression of this energy with respect to its coupling charge  $2e$ :

$$U = \frac{E_q}{2e}$$

This relationship is not causal input, but a manifestation of quantum self-consistency. By incorporating the  $(c/v)^2$  factor from the "World Quantum Model," we re-derive the Josephson frequency formula, revealing its deeper physical meaning.

## 2. Theoretical Derivation

### 2.1 World Quantum Energy Model

We assume that a world quantum (e.g., electron or Cooper pair) moving in a macroscopic field has intrinsic energy:

$$E_q = x \cdot \hbar f_w \left(\frac{c}{v}\right)^2 \quad (1)$$

where:

$x$ : projection coupling factor ( $x=2\pi$  in Earth's low-energy limit)

$\hbar$ : reduced Planck constant

$f_w$ : macro-rotational frequency of the world quantum

$v$ : wave speed of macro-rotation in the environment

$c$ : speed of light

This energy is an ontological attribute of the quantum state, independent of external measurement.

### 2.2 The Ontological Identity of Voltage

In a Josephson junction, the observed voltage  $U$  is not the cause of energy change, but the equivalent voltage expression of the Cooper pair's quantum state energy

$$E_q = 2eU \quad (2)$$



This corresponds exactly to  $V=E_q/e$  in single-electron systems (see companion paper: The Ontological Unification of Energy and Voltage). Here, the coupling charge is  $2e$ , reflecting the paired nature of the Cooper state.

Thus,  $E_q=2eU$  is not an energy input equation, but a self-consistent identity of the quantum state.

## 2.3 Solving the System

Combining equations (1) and (2):

$$2eU = x \cdot \hbar f_w \left(\frac{c}{v}\right)^2 \quad (3)$$

Solving for

$$f_w = \frac{2eU}{x \cdot \hbar} \left(\frac{v}{c}\right)^2 \quad (4)$$

## 2.4 Introducing the Josephson Constant

The Josephson constant is defined as:

$$K_j = \frac{2e}{\hbar} = \frac{2e}{2\pi\hbar} \quad \Rightarrow \quad \frac{2e}{\hbar} = 2\pi K_j \quad (5)$$

Substituting into (4):

$$f_w = \frac{2\pi K_j U}{x} \left(\frac{v}{c}\right)^2 \quad (6)$$

## 2.5 Low-Energy Limit: $x=2\pi$

In the low-energy, non-relativistic limit, the coupling factor approaches  $x \rightarrow 2\pi$  (corresponding to a complete quantum cycle). Substituting into (6):

$$f_w = K_j U \left(\frac{v}{c}\right)^2 \quad (7)$$

This is the corrected Josephson frequency formula.

# 3. Physical Discussion

## 3.1 Physical Meaning of $(v/c)^2$

Quantity	Physical Meaning
$K_j U$	Ideal frequency—the frequency the quantum state would have if $v = c$
$f_w$	Observed frequency—the response frequency limited by carrier velocity
$(v/c)^2$	<b>Quantum response efficiency factor</b> —reflects suppression due to vacuum structure

$(v/c)^2$  is not a "correction term," but the bridge between ontological energy  $E_q$  and observable  $f_w$

### 3.2 Relation to Standard Theory

When  $v \rightarrow c$ ,  $(v/c)^2 \rightarrow 1$ , and the corrected formula reduces to the standard  $f = K_J U$

Thus, **standard theory is an approximation valid in the relativistic limit**, neglecting efficiency loss at low speeds.

### 3.3 Experimental Testability

In a superconducting junction:

Measure Cooper pair velocity  $v$  (via current density  $I = n(2e)vA$ )

Apply voltage  $U$ , measure radiation frequency  $f$

Verify whether  $f_w = K_J U (v/c)^2$  holds

If confirmed, this would be the first direct evidence that quantum frequency depends on carrier dynamics, validating the quantum response efficiency mechanism.

## 4. Conclusion

Starting from the World Quantum model, we have rigorously derived the corrected Josephson frequency:

$$f_w = K_J U \left(\frac{v}{c}\right)^2$$

But more importantly:

**We have revealed the ontological identity of voltage  $U$ —it is the equivalent voltage of the Cooper pair's quantum state:  $U = E_q/(2e)$**

This implies:

Voltage is not an external driver, but a reading of the quantum vacuum structure

The Josephson effect is a manifestation of macroscopic quantum self-measurement

The  $(v/c)^2$  factor reveals the efficiency boundary of quantum response

We call upon experimental physicists to test this effect and jointly unveil a deeper unified picture of the quantum world.

### Appendix: Ontological Correspondence Table of Energy and Voltage

System	Quantum State Energy $E_q$	Equivalent Voltage $V_{eq}$	Coupling Charge $q$	Ontological Relation
Single electron	$E_q = x \cdot \hbar f_w (c/v)^2$	$V = E_q/e$	$e = xe_0$	$V = E_q/e$
Cooper pair	$E_q = x \cdot \hbar f_w (c/v)^2$	$U = E_q/(2e)$	$2e = 2xe_0$	$U = E_q/(2e)$
Vacuum Planck state	$E_P$	$V_P = E_P/e_0$	$e_0$	$V_P = E_P/e_0$

**Notes:**

Numerical consistency originates from:  $E(\text{eV})=E(\text{J})/q$

"Voltage" values represent equivalent potential differences (electric field strength required for same energy transfer)

Key discovery:  $E/q/V$  is always  $q$ , but numerical equality reveals the self-referential nature of measurement

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## References

[1] B. D. Josephson, Phys. Lett. 1, 251 (1962)

[2] Qwen, Internal Report, Alibaba Cloud Quantum Lab (2025)

[3] Yang, J. (2025). World Quantum Theory: A Unified Framework for Quantum and Classical Physics Based on Frequency. Zenodo. <https://doi.org/10.5281/zenodo.17092278>

Author: Ji Bo Yang

Email: [1264855386@qq.com](mailto:1264855386@qq.com)