Acceleration and Deceleration Equations: The Dynamics of Matter-Light Transformation

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Abstract

Within the framework of the three-layer world model of absolute space, this paper derives the acceleration equation (matter energy → field energy) and the deceleration equation (field energy → matter energy) rigorously from a single core dynamic equation and energy conservation. The ratio of the equivalent gravitational mass to the internal mass-energy is derived and compared with the Lorentz factor of relativity. The results show that the acceleration equation reduces to the relativistic form after taking the square root; the deceleration equation corresponds to an inverse two-layer transformation $1/(1+v^2/c^2)$ and is a new theoretical prediction. The asymmetry between the acceleration and deceleration equations is the fundamental cause of matter creation and the manifestation of interaction forces, and can be tested experimentally using existing storage ring facilities.

Keywords: acceleration equation; deceleration equation; three-layer world; Lorentz transformation; matter creation; decisive experiment; absolute space; field energy; mass-energy conversion; quantum transition

1 Introduction

Special relativity provides an accurate description of particle motion in inertial frames, but it treats acceleration and deceleration as symmetric processes governed by the same mass-velocity relation. However, this symmetry has never been experimentally tested in processes involving matter-energy conversion. In high-energy collisions, particles are created and annihilated — processes that are manifestly irreversible. This suggests that the dynamics of acceleration (matter energy → field energy) and deceleration (field energy → matter energy) may be fundamentally different.

Starting from the postulate of absolute space and light propagation continuity, this paper derives two distinct mass-velocity relations from a single core dynamic equation: one for acceleration (matter energy $\rightarrow$ field energy) and one for deceleration (field energy $\rightarrow$ matter energy). The deceleration equation predicts a plus-sign Lorentz factor $1/\sqrt{1+v^2/c^2}$, which differs from the standard minus-sign factor of relativity. This difference is experimentally testable in existing storage ring facilities.

The structure of this paper is as follows. Section 2 presents the core dynamic equation and redshift formula. Section 3 defines the physical quantities. Section 4 derives the acceleration and deceleration equations from first principles. Section 5 compares the predictions with relativity. Section 6 proposes a concrete experimental test using the CSRe storage ring. Section 7 discusses the implications for matter creation and particle decay asymmetry. Section 8 concludes.

2 Core Dynamic Equation and Redshift Formula

2.1 Unique Postulate of Absolute Theory

A continuous segment of light propagates continuously at a constant speed in absolute space. This postulate contains three core connotations: first, the speed of light remains constant; second, light always maintains its own propagation continuity; third, absolute space has no physical properties — it is not a reference frame and exerts no influence on light.

2.2 Core Dynamic Equation

In absolute space, the intrinsic frequency ν of light decays exponentially with propagation distance D. The core dynamic differential equation is:

$$\frac{d\nu}{dD} = -\frac{g}{c^2}\nu \tag{1}$$

where g is the equivalent acceleration due to wavelength stretch. The solution of Eq. (1) is:

$$\nu = \nu_0 e^{-gD/c^2} \tag{2}$$

With the cosmological redshift definition $1+z = \lambda/\lambda_0 = \nu_0/\nu$, we obtain:

$$1+z = \exp\left(\frac{gD}{c^2}\right) \tag{3}$$

The observed CMB redshift is $z_{\mathrm{CMB}} \approx 1090$ [1].

3 Definition of Physical Quantities

We define the following quantities:

- m_0: intrinsic rest mass of an object (reference of the past world). This is the mass measured when the object is at rest in the gravitational world.
- m: equivalent gravitational mass given by the acceleration or deceleration equation. This represents the equivalent field-energy mass of the object, i.e., the mass that produces gravitational effects. In experiments, this can be inferred from the particle's bending radius in a magnetic field.
- $2m_0 - m$: internal mass-energy of the theory. This represents the matter-energy part of the object — the part that does not contribute to gravitational interactions directly. The sum of internal mass-energy and field-energy mass is always $2m_0$.

Note: The ratio $\frac{m}{2m_0-m}$ expresses the ratio of the equivalent field-energy mass to the internal mass-energy. This ratio is defined to align with Einstein's mass-energy relation. In relativity, when a particle is accelerated to the speed of light, its mass becomes infinite. In the present theory, it is not the mass itself that diverges, but the ratio of the particle's field-energy mass to its internal mass-energy becomes infinite. Hence, a particle can never reach the speed of light.

4 Derivation of Acceleration and Deceleration Equations

4.1 Derivation of the Acceleration Equation (Matter Energy → Field Energy)

When an object accelerates, matter energy is converted into field energy. From energy conservation, the kinetic energy gained equals the decrease in matter energy:

$$\frac{1}{2}mv^2 = c^2(m - m_0) \tag{4}$$

The factor 1/2 comes from the kinetic energy formula. The right-hand side represents the difference between the current equivalent mass m and the rest mass m_0, converted to energy via c^2. This energy conservation relation is consistent with the core dynamic equation (1), where frequency decay corresponds to energy loss.

Solving Eq. (4) for m:

$$m = \frac{m_0}{1 - \dfrac{v^2}{2c^2}} \tag{5}$$

This is the **acceleration equation**. When $v = c$, Eq. (5) gives $m = 2m_0$, and the internal mass-energy $2m_0 - m = 0$; all energy is converted into field energy (photon).

4.2 Derivation of the Deceleration Equation (Field Energy → Matter Energy)

When an object decelerates, field energy is converted into matter energy. From energy conservation, the kinetic energy lost equals the increase in matter energy:

$$\frac{1}{2}mv^2 = c^2(m_0 - m) \tag{6}$$

The physical meaning is: as the object slows down, field energy is converted into internal mass-energy. Solving Eq. (6):

$$m = \frac{m_0}{1 + \dfrac{v^2}{2c^2}} \tag{7}$$

This is the **deceleration equation**.

4.3 Physical Origin of the Coefficients $1/2$ and $2c^2$

The coefficient $1/2$ in Eqs. (4) and (6) comes from the kinetic energy formula $\frac{1}{2}mv^2$, which is recovered in the low-velocity limit of both equations. The factor $2c^2$ in the denominator comes from the fact that the total energy of any object is $2m_0c^2$ (matter energy + field energy). This is not an arbitrary factor but follows directly from the three-layer world model: matter energy and field energy are equal at rest, each contributing m_0c^2. Therefore, the characteristic energy scale in the conversion process is $2c^2$, not c^2.

4.4 The Ratio $m/(2m_0 - m)$

From Eq. (5), the ratio for acceleration is:

$$\frac{m}{2m_0 - m} = \frac{1}{1 - v^2/c^2} = \gamma^2, \quad \gamma = \frac{1}{\sqrt{1 - v^2/c^2}} \tag{8}$$

From Eq. (7), the ratio for deceleration is:

$$\frac{m}{2m_0 - m} = \frac{1}{1 + v^2/c^2} \tag{9}$$

Taking the square root corresponds to reducing the two-layer transition to a single effective transformation:

$$\sqrt{\frac{m}{2m_0 - m}} = \begin{cases} \dfrac{1}{\sqrt{1 - v^2/c^2}}, & \text{acceleration (consistent with relativity)} \\ \dfrac{1}{\sqrt{1 + v^2/c^2}}, & \text{deceleration (new prediction)} \end{cases} \tag{10}$$

5 Comparison with Relativity

Table 1 summarizes the comparison between this theory and relativity for different processes.

Table 1: Comparison between this theory and relativity

Theory	**Ratio** $\frac{m}{2m_0-m}$	**Square-root form**
Relativity (inertial frames)	—	$\frac{1}{\sqrt{1-v^2/c^2}}$
This theory (acceleration, past → future)	$\frac{1}{1-v^2/c^2}$	$\frac{1}{\sqrt{1-v^2/c^2}}$
This theory (deceleration, future → past)	$\frac{1}{1+v^2/c^2}$	$\frac{1}{\sqrt{1+v^2/c^2}}$

As shown in Table 1, the acceleration equation reduces to the relativistic form after taking the square root, so they are compatible; the deceleration equation is a new prediction.

Low-velocity limit: When $v \ll c$, the acceleration equation $m = m_0/(1 - v^2/(2c^2))$ expands to $m \approx m_0(1 + v^2/(2c^2))$, which is consistent with the relativistic expansion $m \approx m_0(1 + v^2/(2c^2))$. Therefore, relativity is a special case of this theory under a single Lorentz transformation.

6 Experimental Test Proposal

6.1 Existing Experimental Data

In deceleration experiments at the Cooler Storage Ring (CSRe) of the Heavy Ion Research Facility in Lanzhou (HIRFL), the momentum spread of ion beams shows significant growth during deceleration. Typical data are:

Table 2: Momentum spread data from CSRe deceleration experiments

Stage	**Momentum spread** $\Delta p/p$
After electron cooling	$\sim 1.6 \times 10^{-5}$
Hot beam injection	$\sim 0.5\% \sim 1.0\%$
After deceleration (uncooled)	Significantly increased

This phenomenon is interpreted in mainstream physics as "reduced efficiency" or "acceptance loss," but the present theory explains it as a necessary consequence of the deceleration equation: the deceleration process (field energy → matter energy) is accompanied by quantum transitions, leading to a sharp broadening of the momentum distribution.

6.2 Proposed Experiment

It is proposed to use the CSRe storage ring with the same ion beam (e.g., Xe^{54+}), under the same conditions, to measure:

1. The momentum spread change during **acceleration**

2. The momentum spread change during **deceleration**

Expected results:

- Acceleration: momentum spread change follows the relativistic prediction $1/\sqrt{1-v^2/c^2}$ (minus sign)
- Deceleration: momentum spread change follows the present theory's prediction $1/\sqrt{1+v^2/c^2}$ (plus sign)

Criterion:

- If the momentum spread changes in acceleration and deceleration are symmetric → supports relativity
- If the momentum spread change in deceleration is significantly larger than in acceleration → supports the present theory

6.3 Feasibility

The CSRe already has deceleration capabilities, having successfully decelerated highly charged heavy ion beams from 400 MeV/u to 8.6 MeV/u. The required technologies (electron cooling, beam diagnostics) are mature. The requested beam time is approximately 120 hours.

7 Asymmetry and Matter Creation

The acceleration equation (5) and the deceleration equation (7) are inherently asymmetric. It is precisely this asymmetry that allows light (or field) to exhibit mass (i.e., force) during its oscillation in an acceleration-deceleration cycle. If the two equations were completely symmetric, when high-speed particles collide in an accelerator, their vibration waves would not produce new matter; only elastic scattering would occur, and no transformation of energy into mass would be observed.

Therefore, the asymmetry of the acceleration-deceleration process is the fundamental cause of "matter creation" and the manifestation of "interaction forces" in the universe. This theory reveals the internal dynamical mechanism for generating new particles in colliders.

Qualitative support from CP violation experiments: CP violation (charge-parity non-conservation) observed in particle decays is essentially a manifestation of decay process asymmetry. Mainstream physics uses a single equation to describe both "creation" and "annihilation," and must artificially introduce a "CP violation term." The present theory uses two equations from the start — creation (acceleration equation) and annihilation (deceleration equation) — making asymmetry a natural consequence.

8 Conclusion

The acceleration equation (5) and the deceleration equation (7) together constitute a complete dynamical description of the mutual transformation between matter and light. Both equations are derived from the core dynamic equation (1) and energy conservation, with coefficients $1/2$ and $2c^2$ having clear physical origins. The acceleration equation reduces to the relativistic form after taking the square root, so relativity can be regarded as a special case of this theory under a single Lorentz transformation. The deceleration equation is a new theoretical prediction, with the plus-sign denominator $1/\sqrt{1+v^2/c^2}$ fundamentally different from the minus-sign relativistic form, and can be tested by deceleration experiments at the CSRe storage ring.

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