On the Geometric Origin of Mass and the Universal Speed Limit: An Interpretation Based on Intrinsic Celerity Conservation

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Abstract

Standard physical theories treat the speed of light (c) as an imposed boundary and rest mass as an intrinsic property of matter. This paper proposes a fundamental inversion of this perspective. By introducing the **Axiom of Intrinsic Celerity**, we postulate that all fundamental constituents of nature propagate through four-dimensional spacetime with a constant magnitude of velocity equal to c. We demonstrate that macroscopic "rest mass" is emergent—resulting from the confinement of this intrinsic velocity into microscopic, cyclic motion (internal kinetic energy). Consequently, the formation of composite structures necessitates the conversion of linear spatial velocity into structural potential, strictly enforcing the condition $|\vec{v}| < c$ for all massive bodies. This geometric framework naturally yields the mass-energy equivalence ($E = mc^2$) without recourse to complex field theoretic derivations.

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1 Introduction

In classical mechanics, kinetic energy and potential energy are traditionally viewed as distinct physical entities. In Special Relativity, the speed of light is a universal constant, yet the underlying mechanism for *why* matter cannot transcend this limit remains abstract to the uninitiated. Furthermore, while the famous equation $E = mc^2$ quantifies the energy content of mass, it does not fully elucidate the physical nature of mass itself.

This paper explores a hypothesis rooted in physical intuition: that the distinction between matter and radiation is merely topological. We argue that what we perceive as "potential energy" or "mass" in composite structures is, in reality, kinetic energy that has been spatially confined. Thus, the universal speed limit is not a barrier acting on matter from the outside, but a mathematical consequence of the conservation of a total velocity vector.

2 The Axiom of Intrinsic Celerity

We begin with a single, fundamental postulate regarding the motion of elementary entities (e.g., fundamental particles prior to mass acquisition mechanisms):

> **Axiom:** The magnitude of the total velocity vector ($\mathbf{U}$) of any fundamental entity in the spacetime manifold is invariant and always equals c.

Let $\mathbf{U}$ be resolved into two orthogonal components:

1. **Translational Velocity ($\vec{v}_{ext}$):** The macroscopic velocity observed in 3D space (linear displacement).

2. **Internal/Structural Velocity ($\vec{v}_{int}$):** The velocity component directed along internal dimensions or manifested as microscopic confinement (spin, vibration, or orbital motion within a composite system).

The conservation of total celerity dictates the following Pythagorean relationship:

$$|\vec{v}_{ext}|^2 + |\vec{v}_{int}|^2 = c^2 \tag{1}$$

3 The Origin of Mass as "Trapped" Motion

In this framework, a fundamental particle moving linearly without interaction corresponds to pure radiation (a photon), where $|\vec{v}_{int}| = 0$ and thus $|\vec{v}_{ext}| = c$.

However, when particles interact to form a composite object (an atom or a molecule), the constituent particles are subjected to binding forces. Intuition suggests that "kinetic energy is lost to potential energy." We reinterpret this precisely: linear motion is **diverted** into internal cyclic motion to maintain the structure.

We define the **Rest Mass (m_0)** of a system not as a scalar invariant, but as a measure of this internal activity. The "potential energy" holding the object together is effectively the sum of the kinetic energies of the constituents trapped within the system's center of mass frame.

When an object is macroscopically at rest ($\vec{v}_{ext} = 0$), Equation (1) implies:

$$|\vec{v}_{int}| = c \tag{2}$$

This implies that for a stationary object, the entirety of its fundamental nature is moving at the speed of light *internally*.

4 Derivation of Energy Equivalence

The total energy (E) of a system is proportional to the square of its total velocity vector. Since $|\mathbf{U}| = c$ is constant, the total energy is conserved.

If we define mass (m) as the physical manifestation (or the inertia coefficient) of the internal velocity component, then the energy contained within a "resting" object is simply the energy of this internal light-speed motion.

$$E_{rest} \propto |\vec{v}_{int}|^2 \quad \Longrightarrow \quad E = mc^2 \tag{3}$$

Here, $E = mc^2$ is not merely a conversion formula, but an identity statement: Mass *is* the energy of motion (c^2) confined to a specific region of space.

5 The Geometric Necessity of $|\vec{v}| < c$

From the equation $|\vec{v}_{ext}| = \sqrt{c^2 - |\vec{v}_{int}|^2}$, the speed limit of massive bodies becomes self-evident.

For any object that possesses structure (and thus mass), the internal velocity must be non-zero ($|\vec{v}_{int}| > 0$). It follows mathematically that:

$$|\vec{v}_{ext}| < c \tag{4}$$

As we attempt to accelerate an object macroscopically ($|\vec{v}_{ext}| \to c$), we are essentially trying to rotate the total velocity vector $\mathbf{U}$ purely onto the spatial axis. However, because the object requires internal motion to exist as a coherent structure (to maintain its "potential" or binding), it can never fully surrender its internal velocity component. Thus, it can never reach c.

6 Dynamic Mass and Time Dilation

Consider the scenario where an external force accelerates a massive body, increasing its macroscopic velocity $|\vec{v}_{ext}|$ towards c. According to the conservation law $|\vec{v}_{ext}|^2 + |\vec{v}_{int}|^2 = c^2$, any increase in spatial translation must be compensated by a corresponding decrease in the magnitude of internal structural velocity $|\vec{v}_{int}|$.

This geometric constraint leads to a natural derivation of two fundamental relativistic phenomena:

6.1 Time Dilation

If we posit that the "passage of time" for a physical object is determined by the rate of its fundamental internal cycles (its "internal clock"), then the reduction of $|\vec{v}_{int}|$ implies a slowing of these cycles relative to a stationary observer.

As $|\vec{v}_{ext}|$ approaches c, $|\vec{v}_{int}|$ approaches zero. Thus, for an object moving at the speed of light (like a photon), internal time stands still. Time dilation is therefore not a distortion of an abstract temporal dimension, but a mechanical necessity: *the faster one moves through space, the slower one must move through one's own internal existence.*

6.2 Dynamic Mass

Furthermore, as we inject energy into the system to increase $|\vec{v}_{ext}|$, we approach a geometric asymptote. In standard relativity, this is described as the relativistic mass increasing ($m = \gamma m_0$).

In our model, this phenomenon is interpreted as the increasing difficulty of rotating the total velocity vector $\mathbf{U}$ entirely onto the spatial axis. The energy supplied to the system, unable to push the total celerity magnitude beyond c, effectively accumulates within the system's total momentum density. This accumulation manifests macroscopically as increased inertia, or "dynamic mass." The infinite energy required to reach light speed is simply the energy required to completely halt the internal structural motion that defines the object's existence as matter.

7 Conclusion

We have presented a model where the universe consists of a single fundamental velocity: the speed of light. Matter is simply "light" that has been folded upon itself, converting linear propagation into localized, structural circulation.

This perspective validates the intuition that the formation of matter involves the transformation of linear kinetic energy into structural "potential" energy (mass). Consequently, the speed limit c is not a ceiling imposed from above, but a budget constraint from within: one cannot spend all motion on travel if one needs to spend a portion merely to exist.

Acknowledgments

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