On the Nature of Time, Matter and Light: A Non-Contracting Spatial Framework

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ABSTRACT

This work challenges several fundamental assumptions of modern physics, proposing an alternative nature in which proper time, its property, rather than the geometry of spacetime, constitutes the main physical variable. It argues that key concepts traditionally considered fundamental—namely, spatial contraction, the invariance of the speed of light as an absolute natural limit, and the strict separation between the nature of matter and radiation—are interpretative constructs, rather than inevitable consequences of empirical evidence or mathematical formalism.

In this framework, relativistic phenomena emerge from variations in the temporal regime of physical systems, determined by their energy conditions, without requiring any physical contraction of space. Proper time is elevated to a defining criterion of materiality: systems that possess internal dynamics exhibit proper time, while its absence defines a distinct physical regime.

Rest mass is reinterpreted as a regime-dependent parameter, associated with the existence of proper time, rather than a fundamental attribute of matter. C is reformulated as a limit that separates regimes with and without proper time, rather than a purely kinematic limit. From this perspective, light is described not as an entity distinct from matter, but as an extreme state of matter characterized by zero proper time and zero rest mass, while still maintaining full physical capacity for interaction.
In this approach, the need for physical space contraction is eliminated, while remaining compatible with established experimental results. The proposed framework offers a unified and conceptually unified interpretation of matter, energy, and radiation, and opens the possibility of new experimental criteria capable of distinguishing between the geometric and temporal nature of physical reality.

(Keywords: proper time; ontology of physics; exotic matter; light; mass and energy; speed of light; relativity; gravitation; space contraction)

1. INTRODUCTION

Throughout the 20th century, physics developed a mathematical framework of extraordinary descriptive success, capable of predicting relativistic, quantum, and cosmological phenomena with acceptable precision. However, this operational success was accompanied by a progressive interpretative consolidation, in which specific historical interpretations came to be considered inevitable physical realities, rather than ontological choices.

Among these interpretations, three widely accepted assumptions stand out: (1) the contraction of space as a real physical phenomenon; (2) the interpretation of the constant C as an absolute ontological limit of the Universe; and (3) the strict separation between matter and radiation as fundamentally distinct categories. This work argues that none of these assumptions is strictly required by experimental evidence or the formal structure of relativistic physics.

A reformulation of its nature is proposed, centered on proper time as a fundamental physical variable. Within this framework,

relativistic effects arise from variations in the temporal dynamics of physical systems associated with their energy conditions, while space is treated as an invariant frame of reference. Light is interpreted as an exotic state of matter, characterized by the absence of proper time and rest mass, but retaining essential physical properties such as energy, momentum, and the capacity for interaction.

The aim of this work is to relocate the causal basis of known physical phenomena, eliminating conceptual ambiguities and preserving their nature.

2. Mass, Matter, and Energy: A Necessary Distinction

The historical identification of mass with matter has become conceptually insufficient in light of modern physics;

$$E = mC^2 \quad \textbf{(2.1)}$$

$$E_v = m_v {C_v}^2 \quad \textbf{(2.2)}$$

These relations establish that rest mass corresponds to a specific form of energy, rather than a universal criterion of materiality. It is therefore necessary to distinguish clearly between the following concepts:

-Energy: a physical quantity associated with the capacity to produce observable effects;
-Rest mass: a parameter associated with systems capable of sustaining stable internal dynamics.

2.1 Matter as an interactive entity

Matter is defined as any physical entity capable of exchanging energy and momentum with other systems, independently of the presence of rest mass. This definition is based exclusively on observable interaction properties, including momentum transfer, impact, absorption, emission, and gravitational influence.

2.2 Rest mass as a regime parameter

Rest mass should be understood as a parameter associated with systems possessing non-zero proper time and evolving internal dynamics. In extreme energy regimes, the relevance of rest mass decreases—not due to a disappearance of energy, but due to the collapse of the temporal regime that gives it physical meaning.

$$C_v\, t_v = C_0\, t_0 \quad (2.3)$$

$$\frac{C_0}{C_v} = \frac{t_v}{t_0} \quad \textbf{(2.4)}$$

From relativistic relations:

$$E_v = \frac{E_0}{\sqrt{1-\frac{v^2}{C^2}}} \quad \textbf{(2.5)}$$

$$E_v = \frac{E_0}{\frac{t_v}{t_0}} \quad \textbf{(2.6)}$$

$$E_v\, t_v = E_0\, t_0 \quad \textbf{(2.7)}$$

$$m_v C_v (C_v\, t_v) = m_0 C_0 (C_0\, t_0) \quad \textbf{(2.8)}$$

In the present model, the producto $m_v\, C_v$ constitutes an invariant quantity between reference frames, because $(C_v\, t_v)$= $(C_0\, t_0)$.

$$m_v C_v = m_0 C_0 \quad \textbf{(2.9)}$$

$$m_v = m_0 \frac{C_0}{C_v} \quad \textbf{(2.10)}$$

$$m_v = m_0 \frac{t_v}{t_0} \quad \textbf{(2.11)}$$

$$\mathrm{m_V}=\mathrm{m_0}\sqrt{\frac{C^2-v^2}{c^2}} \quad \textbf{(2.12)}$$

This expression shows that, as v→C, proper time collapses and mv→0, defining C as the ontological boundary between regimes with and without proper time.

From de invariants:

$(C_v\, t_v = C_0\, t_0$ and $E_v\, t_v = E_0\, t_0)$

and identifying $\boldsymbol{t_v}$ with the proper time **τ** of the system, it follows that

$$C_v = C_0 \frac{\tau_0}{\tau_v} \text{ and } E_v = E_0 \frac{\tau_0}{\tau_v}$$

Therefore, energy, the regime-parameter C_v, and proper time are linked by the fundamental relation:

$$\frac{\mathbf{E_v}}{\mathbf{E_0}} = \frac{\mathbf{C_v}}{\mathbf{C_0}} = \frac{\boldsymbol{\tau_0}}{\boldsymbol{\tau_v}}$$

2.3 The transformation of matter and energy

Let's see what happens when matter is lost.

$$E_v\, t_v = E_0\, t_0 \quad \textbf{(2.13)}$$

$$E_v = E_0 \frac{t_v}{t_0} \quad \textbf{(2.14)}$$

$$E_v = E_0 \sqrt{\frac{C^2}{C^2-v^2}} \quad \textbf{(2.15)}$$

Energy increases in inverse proportion to the loss of mass.

2.4 Ontological continuity between matter and radiation

Processes such as absorption, emission, and matter–radiation conversion occur without physical discontinuity. The distinction between matter and radiation corresponds to different regimes of energy and proper time.

The transformation of matter into radiation is not spontaneously reversible, as it involves the loss of the temporal regime that defines materiality. The reconstruction of matter requires the reestablishment of a proper temporal structure under specific energetic conditions.

3. Proper Time as a Fundamental Physical Variable

Spatial quantities are operationally inferred through clocks, signals, and synchronization procedures. Frequencies, periods, and durations form the empirical basis of physical measurement. Proper time is thus understood as an emergent physical property associated with matter.

3.1 Proper Time [5] and Physical Processes

A physical system is considered material if it possesses measurable internal processes. These processes define proper time. Without proper time, no evolution, history, or internal dynamics can exist.

3.2 Time Dilation as a Primary Phenomenon

Time dilation is a real physical effect affecting systems in different energy regimes. The variation lies in the rate of temporal evolution, without requiring any dynamical modification of space.

3.3 Space as a reference structure

Space functions as a reference structure necessary for describing physical events. In this framework, it is not required to attribute independent physical dynamics to space itself.

3.4 Elimination of space contraction

Observed length variations are interpreted as consequences of physical processes in matter, driven by temporal dynamics associated with energy conditions. No physical contraction of space is required.

4. C as a Liit of the Nature of Matter

C does not lmit the propagation of entities without prope time, but rather defines the boundary of rgimes in which proper time—and thus internal dynamics—can exist.

4.1 C and the mass-energy equivalence

Within this framework:

$$E_v = m_v C_v^{\,2} \qquad \textbf{(4.1)}$$

C defines the energy scale associated with material regimes possessing proper time, rather than a kinematic limit accessible to massive systems.

4.2 The regime boundary

As velocity approaches C, the energy required to sustain proper time diverges and mv→0. The boundary is defined by temporal collapse, not by a purely kinematic constraint.

5. Light as an Exotic State of Matter

Light is not ontologically distinct from matter but represents a limiting regime of it. All electromagnetic radiation originates from material processes.

5.1 Absence of Proper Time

The defining characteristic of free light is:

$$d\tau = 0 \qquad \textbf{(5.1)}$$

Without proper time, light exhibits no internal evolution.

5.2 Physical properties

Despite having no rest mass, light carries energy and momentum, exerts radiation pressure, and interacts gravitationally. Its lack of rest mass reflects a distinct regime, not an absence of materiality.

5.3 Physical structure

Light does not possess evolving internal structure but retains a well-defined physical description through energy, momentum, phase, and polarization. It represents the limiting case of the material regime where

$$m_v = 0 \text{ e } d\tau = 0 \quad \textbf{(5.2)}$$

6. Impact and Absorption as Materiality Criteria

6.1 Moment transfer

Light transfers momentum and exerts radiation pressure, producing measurable dynamic effects in material systems. These interactions demonstrate that light is capable of inducing real physical changes, reinforcing its status as a physically operative entity within the framework of interaction-based materiality.

6.2 Absorption

In absorption processes, light ceases to exist as a propagating entity and its energy is directly transferred to the absorbing material system. This transition corresponds to the conversion of a regime without proper time into a regime endowed with proper time and internal dynamics.

Within this framework, absorption is not the destruction of an entity, but a transformation between distinct temporal regimes. The energy carried by light—characterized by zero proper time—is incorporated into the absorbing system, where it contributes to the reconfiguration of its internal temporal structure.

6.3 Proper Time of the Receiving System

Following absorption, the receiving system undergoes a modification of its internal state, reflected in its proper time evolution. The incorporated energy may lead to excitation, thermalization, or subsequent emission processes, all of which occur within a regime where proper time is defined.

This highlights that the physical relevance of absorption lies not only in energy transfer, but in the restoration or modification of a temporal regime capable of sustaining internal dynamics. The receiving system thus becomes the locus where a previously non-temporal regime (light) is reintegrated into a temporally evolving physical structure.

7. Physical and Observational Consequences

7.1 Gravitational interaction of light

Light is deflected by gravitational fields due to its energy and momentum content. In the present framework, this interaction does not require the attribution of physical dynamics to space itself, but instead follows directly from the interaction between energy-bearing systems and gravitational potential. The observed deflection is thus interpreted as a consequence of energy-dependent temporal regimes rather than geometric curvature.

7.2 Gravitational delay

The propagation of light in gravitational fields exhibits measurable time delays, as confirmed by experimental observations. Within this framework, such delays are interpreted as resulting from variations in the temporal regime associated with gravitational potential, rather than from modifications in spatial geometry. The effect reflects changes in the evolution rate of physical processes, consistent with the primacy of proper time.

7.3 Synchronization systems

Satellite-based navigation systems provide direct operational evidence for the primacy of proper time. Accurate positioning requires continuous temporal corrections due to both relative motion and gravitational potential differences. These corrections demonstrate that measurable physical effects arise from variations in temporal regimes, reinforcing the interpretation that time, rather than space, plays the fundamental role in relativistic phenomena.

7.4 Magneto-Optical Interaction and Temporal Regimes

The Faraday effect can be interpreted as a consequence of the interaction between a radiation regime ($\tau = 0$) and a material regime ($\tau > 0$), whose internal temporal structure is modified by an external magnetic field, leading to observable changes in light propagation.

8. Conclusion

This work has proposed an ontological reformulation of relativistic physics centered on proper time as the fundamental physical variable, while treating space as an invariant reference structure. Within this framework, relativistic effects arise from variations in the temporal regime of matter, rather than from geometric transformations of space.

C is interpreted as an ontological boundary separating regimes with and without proper time, redefining its role beyond that of a purely kinematic limit. Light is described as an exotic state of matter, characterized by the absence of proper time and rest mass, yet retaining full physical capacity for interaction.

By eliminating the need for physical space contraction, this approach offers a conceptually simpler and ontologically coherent description of relativistic phenomena, while remaining compatible with established experimental results. The reinterpretation of mass, energy, and radiation within a unified temporal framework provides a consistent basis for understanding matter across different regimes.

Future work should focus on the complete mathematical formalization of this model and, critically, on the identification of experimental conditions capable of distinguishing between geometric and temporal interpretations of relativistic effects.

To fully contextualize this proposal, the author's previously published works should be considered as part of a broader theoretical development.

To fully understand this article, the author's published articles should be consulted.

- *Publicado em IJP – Internagional Journal of Physics:* ijp-8-1-2.pdf
- *Publicado em PJST – Pacific Journal Os Science and Technology: pjst25_1_20.pdf (akamai.university)*

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