

Section 1. Introduction

1.1 Why Light Must Be Re-examined

Few concepts in physics are as central, as successful, and yet as conceptually unsettled as light. From classical optics to Maxwellian electrodynamics, from relativity to quantum theory, light stands at the intersection of nearly every decisive transition in modern physics. It is not merely one more physical phenomenon among many. It is one of the principal means by which causality, radiation, measurement, and spacetime structure become intelligible.

Yet the explanatory success of light theory does not fully dissolve its deeper conceptual difficulty. Physics describes the behavior of light with extraordinary precision, but still leaves open the question of what light fundamentally is. Is it ultimately a wave, a particle, an excitation of a field, a propagation rule within spacetime, or the emergent appearance of a deeper structural process? Why does light propagate with an invariant speed for all observers? Why does the same constant also define the upper limit of spacetime-bound motion? And why do quantum and radiative phenomena continue to expose tensions between formal description and ontological clarity?

These are not minor puzzles. They suggest that the mathematics of light may be highly successful while the ontology beneath that success remains incomplete. A theory may predict correctly and still leave its deepest object only partially understood. For this reason, light must be re-examined not because standard physics has failed empirically, but because the conceptual basis of its success may not yet be fundamental enough.

Within the CUWF framework, this re-examination begins from a different starting point. Light is not treated as an isolated primitive object moving through an independently given background. Instead, it is approached as a coherent propagating disturbance mode arising within the Fundamental Wave Basin, or FWB, from which spacetime structure itself later emerges as a derived relational order.

$$U(x, \tau) = U_0 + \delta U(x, \tau)$$

Here U_0 denotes the baseline state of the FWB, while $\delta U(x, \tau)$ denotes structured disturbance within that basin. In the interpretation developed in this paper, light belongs to this second term as a specific coherent propagating regime rather than as a self-standing primitive entity. This shift in viewpoint will allow the constancy of c , its maximality, and the paradoxes surrounding light to be reconsidered from a unified ontological basis.

1.2 The Limits of Standard Interpretation

Standard physics provides extraordinarily powerful descriptions of light. Maxwell's equations unify electric and magnetic phenomena into a coherent dynamical structure. Special relativity places the invariant speed of light at the center of spacetime kinematics. General relativity extends this role into curved spacetime, where light determines null structure and local causal organization. Quantum theory and quantum field theory describe light through quantized interaction, field excitation, and measurement statistics with remarkable experimental success.

Nevertheless, these achievements do not by themselves settle the ontological status of light. At one level, light is treated as a wave. At another, it appears as a particle-like quantum. In relativity, it functions as the invariant boundary of causal structure. In quantum theory, it participates in nonclassical behavior that resists naive localization. These descriptions are not necessarily contradictory at the predictive level, but they do not automatically combine into a fully transparent account of what light is across all levels of reality.

The limitation is therefore not primarily mathematical, but interpretive. Maxwellian theory tells us how electromagnetic structure evolves, but not why that structure should occupy such a privileged place in the architecture of reality. Relativity tells us that c is invariant and fundamental for causal structure, but does not by itself explain why such an invariant should arise at all. Quantum theory describes quantized detection, but leaves unresolved the ontological transition between distributed propagation and localized registration.

This paper does not take these limits as failures of standard physics. On the contrary, the formal and empirical achievements of those theories are preserved throughout. The issue is that formal success

does not automatically imply ontological completion. The CUWF project therefore treats standard theory as an indispensable effective layer while asking whether a deeper wave-entropic ontology can clarify why light has the status it does.

1.3 The Central Thesis of This Paper

The central thesis of this paper is that light is best understood, within the CUWF framework, as a coherent propagating disturbance mode within the Fundamental Wave Basin. In this view, electromagnetic light is not denied, but reinterpreted as an emergent expression of deeper wave structure. Light is therefore neither reduced to a naive classical wave nor treated as a permanently mysterious particle-like object. Its wave-like propagation and particle-like detection are instead read as different manifestations of a deeper structural process unfolding across different ontological levels.

From this perspective, the constancy of the speed of light is not merely a brute empirical fact or an unexplained postulate. It is interpreted as an emergent structural invariant tied to coherence-preserving propagation within the spacetime layer that arises from the deeper organization of the FWB. Likewise, c is maximal not because nature arbitrarily forbids anything faster, but because beyond that threshold coherent propagation ceases to remain structurally admissible within emergent spacetime.

A second thesis follows. Objects with mass cannot surpass c not simply because an external kinematic rule forbids it, but because their localized structural identity becomes increasingly costly to preserve as propagation approaches the coherence boundary. Similarly, quantum entanglement does not violate the light-speed limit because it does not amount to ordinary local propagation through emergent spacetime. It instead reflects deeper relational coherence within a shared wave configuration.

Accordingly, this paper develops what will be referred to as CUWF Light Theory: an interpretation in which light, causal propagation, relativistic invariance, and the major conceptual paradoxes associated with superluminality are unified within a single wave-entropic ontology. The purpose is not to reject Maxwell, relativity, or quantum theory, but to provide a deeper explanatory layer beneath them that remains aligned with the larger CUWF framework.

1.4 Structure of the Paper

The argument proceeds in a staged sequence. Section 2 introduces the principal conceptual tensions surrounding light, including wave-particle duality, invariant speed, the maximal role of c , the appearance of superluminal correlation in entanglement, and the tension between time-symmetric laws and one-way observed radiation. These are presented not as historical curiosities, but as signs that a deeper ontology of light may still be needed.

Section 3 then establishes the ontological foundation of CUWF Light Theory by defining light as a coherent propagating disturbance mode within the FWB. Section 4 develops the claim that the speed of light is constant because it emerges as a coherence-preserving invariant of propagation within the spacetime layer derived from deeper wave-entropic organization. Section 5 extends this account by showing why the same constant also functions as the upper limit of coherent propagation and causal integrity.

Section 6 addresses why no spacetime-bound object can exceed c , relating this limit to localization, structural inertia, and the rising cost of preserving coherent identity near the light boundary. Section 7 clarifies why quantum entanglement does not violate the light-speed limit by distinguishing global wave correlation from local signal propagation. Section 8 then turns to Einsteinian relativity and general relativity, asking how the CUWF interpretation of light relates to the standard role of c in relativistic geometry.

Having established this framework, Section 9 returns to the paradoxes introduced earlier and reinterprets them within CUWF Light Theory, with the aim of showing that many of them arise not from contradiction in nature itself, but from ontological level confusion in the description of light. Section 10 draws broader implications for Maxwellian theory, relativity, photon ontology, information transfer, and the future development of CUWF-based physics. Section 11 concludes by summarizing the central claims and indicating directions for later work.