Section 4. Why the Speed of Light Is Constant

4.1 Reframing c as an Emergent Structural Constant

Within the CUWF framework, the constancy of the speed of light is not treated as an unexplained primitive fact, nor merely as a postulate imposed from the outside upon physical law. It is instead understood as an emergent structural constant arising from the way coherent disturbance propagates within the relational architecture generated from the Fundamental Wave Basin (FWB). In this view, c is not simply "the speed of light" in a descriptive sense. It is the invariant propagation rate associated with a specific class of disturbance modes whose coherence can be stably preserved across the emergent spacetime layer.

This reframing is important because standard physics typically begins with the invariance of c as a formal principle, then derives consequences from it. CUWF asks a prior question: what kind of underlying ontology would make such an invariant natural rather than mysterious? The answer proposed here is that light is a coherent propagating disturbance mode whose admissible transmission is governed by the entropic-relational structure of the emergent geometry. The constancy of c therefore reflects not an arbitrary universal speed cap, but a deeper structural regularity in the way the FWB supports ordered propagation.

To express this schematically, one may write

$c = \lim (\Delta x / \Delta\tau_{eff})$ under coherence-preserving propagation

where $\Delta\tau_{eff}$ denotes the effective entropic-temporal interval associated with propagation across the emergent spacetime layer. The equation is not meant here as a final microscopic derivation, but as a structural statement: c is the limiting propagation rate recovered when coherent transmission remains admissible within the relational geometry emergent from the FWB.

In this sense, c belongs to the architecture of propagation itself. It is not introduced independently of the ontology of light, but arises from that ontology once light is understood as a coherent disturbance mode rather than as a primitive object moving through pre-given empty space.

4.2 c as a Coherence-Preserving Propagation Rate

The CUWF interpretation goes further by specifying what kind of invariant c actually is. It is not merely a measured speed that happens to be the same in every inertial frame. It is the maximum rate at which a light-mode disturbance can propagate while preserving the coherence required for structurally intelligible transmission in the emergent spacetime layer. In short, c is a coherence-preserving propagation rate.

This means that the propagation of light is not defined only by displacement over distance and time in the ordinary kinematic sense. It is also constrained by the requirement that the disturbance maintain phase-consistent and relationally stable transmission across the underlying entropic geometry. If the transmission remains coherent, the propagating structure remains identifiable as the same mode across successive relational nodes. If coherence breaks down, physically intelligible propagation in that form is lost.

This relation may be stated schematically as

$$v\_coh \leq c$$

where v_coh denotes the effective speed of coherent propagation. The inequality is conceptually important. It says that coherent propagation is admissible only up to the invariant boundary c. Below that value, a structured mode can remain relationally stable. At c, the propagation mode reaches the invariant limit characteristic of light. Beyond this boundary, the disturbance would no longer preserve the structural continuity required for light-like transmission in the emergent spacetime layer.

The deeper reason for this limit lies in the fact that propagation in CUWF is not merely movement through a background. It is ordered transmission across a relational-entropic structure whose coherence conditions are non-negotiable. In this sense, c is less like a speed assigned to light after the fact, and more like the lawful expression of what a coherent light-mode transmission can be.

4.3 Why All Observers Recover the Same c

If c is tied to coherence-preserving propagation within the emergent spacetime layer, then its observer-invariance becomes more intelligible. Standard relativity states that all inertial observers recover the same value for c, regardless of the motion of the source or the observer. CUWF does not dispute this result. Rather, it seeks to explain why this invariance should arise from the deeper structure of the theory.

The key point is that observers do not impose c upon reality; they recover c because they themselves are embedded within the same emergent relational geometry in which light-mode propagation is defined. The invariant is therefore not a property of subjective measurement convention, but of the shared structural layer within which both observer and light disturbance participate. Different observers may decompose intervals differently, but they do so within a common coherence-governed architecture. What remains invariant across those decompositions is the propagation constant associated with structurally admissible light-like transmission.

This is why the invariance of c is deeper than a coordinate statement. It reflects the fact that all physically meaningful observers, insofar as they belong to the same emergent spacetime order, measure propagation through the same entropic-relational constraints. The invariance arises because the light-mode is not being compared against arbitrary private clocks and rulers detached from ontology; rather, both measurement systems and light propagation inherit their admissibility conditions from the same underlying organization of the FWB.

A minimal schematic condition for this may be written as

$$C(x_1, x_2; \tau) \geq C\_min$$

where $C(x_1, x_2; \tau)$ denotes the effective coherence relation between two relationally connected positions at an entropic stage τ, and C_min denotes the minimum coherence required for structurally admissible light-like transmission. Because observers situated within the same emergent spacetime layer must reconstruct measurement through this shared coherence structure, they recover the same c as the invariant propagation constant of that layer.

Thus, in CUWF, the invariance of c is not a surprising empirical coincidence. It is the measurable surface of a deeper structural fact: the light-mode propagates according to coherence rules that are not observer-created, but observer-inherited.

4.4 c, Metric Structure, and Entropic Synchronization

The constancy of c acquires its fullest meaning when related to metric structure and entropic synchronization. In standard relativity, c enters directly into the form of spacetime intervals and defines the light-cone structure that organizes causal relations. CUWF accepts this functional role but reinterprets its foundation. The metric significance of c is not primitive. It is emergent from the synchronization conditions that permit coherent propagation across the relational geometry generated from the FWB.

Entropic synchronization here does not mean that all parts of the universe share a single absolute clock. Rather, it refers to the lawful coordination by which relational nodes remain sufficiently aligned for coherent disturbance transmission to retain structural identity. Light is the special case in which this synchronization limit appears in its invariant form. Because light-like propagation tracks the coherence boundary of the emergent spacetime layer, c becomes the constant through which metric structure is effectively stabilized and reconstructed.

This interpretation may be summarized by writing

$$c = \sup \{v : \text{propagation remains coherence-preserving}\}$$

That is, c is the supremum of propagation speeds for which transmission remains coherence-preserving within the emergent spacetime order. The metric structure associated with light-like intervals then reflects the deepest propagation boundary still compatible with relational continuity. In this sense, c is not first a number inside the metric and only later a physical speed. Rather, the metric inherits its operational structure from the invariance of coherent light-mode propagation.

This also clarifies why c stands at the center of causal organization. If spacetime is emergent and if its metric form is reconstructed through stable propagation constraints, then c is the constant that marks the boundary at which such reconstruction remains physically intelligible. Light does not merely travel within a metric. Light, as coherent propagation, helps define the very metric form through which emergent spacetime becomes operationally legible to embedded observers.

If c is the invariant rate at which coherent propagation remains structurally admissible, then it becomes necessary to ask why the same constant also emerges as the upper boundary of physically meaningful transmission.