Section 8. Light-Speed Invariance in Einsteinian Relativity and Its Reinterpretation in CUWF

8.1 The Role of c in Einsteinian Relativity

In Einsteinian relativity, the constant c is not merely an experimentally measured speed associated with light. It is one of the deepest structural constants in the mathematical organization of spacetime. In special relativity, c enters directly into the definition of the spacetime interval and thereby sets the conversion structure between spatial and temporal description. In that framework, c does not function simply as a property of one physical phenomenon among others. It marks the invariant scale that links space, time, and causal admissibility within a single geometric order.

This role may be written in the familiar Minkowski form:

$$ds^2 = -c^2dt^2 + dx^2 + dy^2 + dz^2$$

The significance of this expression is profound. The constant c is built into the structure by which intervals are classified, motions are compared, and causal relations are rendered physically meaningful. It defines the null structure of the spacetime manifold and thereby establishes the condition under which light-like propagation occurs. In that sense, relativity does not treat light merely as a fast object moving within a pre-existing stage. Rather, the observed behavior of light reveals something about the architecture of the stage itself.

Accordingly, the Einsteinian role of c extends well beyond optics. It governs relativistic simultaneity, constrains signal propagation, and determines the boundary between timelike, null, and spacelike relations. Even when light is not the immediate subject of analysis, c remains embedded in the formal grammar of relativistic physics. It is therefore more accurate to say that relativity is structured around the invariance associated with light than to say that it simply happens to include light among its consequences.

8.2 Why c Is Foundational for General Relativity

The role of c becomes even more foundational in general relativity. Once gravitation is reinterpreted as curvature of spacetime rather than as a force acting within an external background, the constant c remains indispensable because it continues to define the local null structure of spacetime and the causal organization of physical influence. Even in curved geometry, light-like propagation remains associated with the condition

$$ds^2 = 0$$

This null condition is not a minor technical detail. It defines the local causal cone at each event, and these local cones in turn determine which directions of transmission, signaling, and interaction remain physically admissible. In this way, c remains central to the relativistic structure even when the geometry is dynamical rather than flat. The light cone is not an optional interpretive image; it is a geometric encoding of causal accessibility.

General relativity therefore depends on c in at least three interconnected ways. First, c remains part of the metric structure through which intervals are described. Second, it defines the null directions that organize local causal geometry. Third, it continues to set the propagation boundary relative to which massive motion, radiation, and signal structure are interpreted. Without this invariant, relativistic geometry would lose the very scale that allows causal order to be articulated in a unified way.

For this reason, any reinterpretation of light within a deeper ontology must take care not to weaken or blur the Einsteinian role of c. If CUWF is to offer a serious ontological deepening rather than an ungrounded alternative, it must preserve the empirical and structural role of c that relativity has already established with extraordinary success.

8.3 Why the CUWF Interpretation Does Not Contradict Relativity

The CUWF interpretation of light does not contradict relativity at the level at which relativity is empirically and mathematically successful. It does not deny invariant light-speed measurements, null structure, relativistic time dilation, length contraction, or the impossibility of driving massive spacetime-

bound objects beyond c. On the contrary, it accepts these as stable features of the emergent spacetime layer accessible to observation.

The difference lies in where explanation is stopped. Relativity, taken on its own, provides a powerful formal framework in which c functions as an invariant structural constant. CUWF asks why this invariant should arise at all. It therefore seeks not to replace the relativistic description, but to place it on a deeper ontological foundation grounded in the Fundamental Wave Basin (FWB), emergent spacetime, and entropic geometry.

This distinction is crucial. A theory can preserve the full predictive content of an established framework while still reinterpreting the deeper basis from which that framework emerges. That is the role CUWF attempts to play here. Einsteinian relativity remains correct as a geometric theory of the observable spacetime layer. CUWF proposes that the reason this layer exhibits an invariant c is that coherent propagation within the deeper wave-entropic organization becomes operationally legible to embedded observers only through a stable emergent limit of this kind.

Thus the CUWF interpretation does not say that relativity is wrong. It says that relativity is descriptively complete at its own level, while remaining ontologically open at a deeper one. The goal is therefore not contradiction, but grounding.

8.4 CUWF as a Deeper Ontological Layer Beneath Relativistic Structure

If relativity describes the structure of emergent spacetime, CUWF attempts to explain why that structure takes the form it does. In this paper, c has been interpreted not as a brute postulate, but as the invariant associated with coherence-preserving propagation within the emergent spacetime layer generated from the FWB. This relation may be stated schematically as

$$c = \sup \{v : \text{propagation remains coherence-preserving within the emergent spacetime layer}\}$$

In this reading, the relativistic role of c is not denied; it is re-grounded. The light-boundary appears within relativistic geometry because that geometry is itself an emergent operational reconstruction of deeper propagation constraints. The metric structure of spacetime is therefore not primary in the

strongest ontological sense. It is a stabilized relational form inherited from the wave-entropic organization of the deeper substrate.

This is where CUWF connects most directly with A-3 Entropic Geometry and the broader Framework Overview. Geometry is not treated as an ontologically self-standing arena. It is an emergent relational ordering produced through admissible organization within the deeper field. The fact that c appears universally within relativistic structure is then no longer mysterious. It is the visible signature of a deeper propagation constraint already built into the lawful coherence conditions of the system.

Under this interpretation, relativity becomes neither false nor merely approximate in a dismissive sense. It becomes the correct geometry of a level of reality whose deeper basis lies beneath it. What Einsteinian formalism captures with extraordinary precision is the operational form of a world whose causal and metric structure are already shaped by the coherence architecture of the FWB.

8.5 What CUWF Clarifies Beyond the Einsteinian Formalism

The main value of the CUWF reinterpretation is that it clarifies why c has the status it has in relativistic physics. Einsteinian relativity tells us with great success that c is invariant and foundational. CUWF attempts to explain why that invariant is the one recovered by embedded observers in the first place. The answer proposed here is that c is the emergent boundary at which coherent propagation remains structurally admissible in the spacetime layer through which observers and measurements are constituted.

This also helps unify several issues that otherwise remain conceptually separate. The constancy of c, its maximal role, the impossibility of superluminal propagation for spacetime-bound objects, and the compatibility of entanglement with relativistic causality can all be read as consequences of one deeper distinction: the distinction between coherence-preserving propagation in emergent spacetime and broader relational structure in the underlying wave-entropic whole.

Finally, CUWF clarifies the relation between light and geometry itself. In standard interpretation, c is inserted into the formal structure of the metric and causal cone. In the present framework, the metric becomes operationally meaningful because coherent propagation already possesses an invariant

boundary. Light does not merely move through relativistic geometry. The stable propagation of the light-mode helps render that geometry legible to observers from within.

If the CUWF account of light is compatible with relativistic structure while also offering a deeper basis for c, then the original paradoxes raised at the outset can now be revisited under a new interpretive framework.