NATURE OF LIGHT AND SPEED LIMIT: RECONFIGURATION WITHOUT DISPLACEMENT IN THE OBSERVER-DEPENDENT THEORY OF EVERYTHING

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ABSTRACT

This paper proposes a reinterpretation of the nature of light and the speed limit c within the Observer-Dependent Theory of Everything (ODTOE) [1]. The central thesis holds that a photon does not "travel" between source and receiver in the classical sense — it constitutes a reconfiguration act: the observation operator $\hat{O}$ actualizes in configuration space $\mathcal{C}$ a new configuration in which excitation energy is present at the receiver instead of the source. The "flight of a photon" is not the translation of an object through space but a sequential change of configurations, each generated by an iteration of the self-observation map Φ. The speed of light c in this interpretation is not a speed of motion but the actualization front velocity: $c = r_0/\tau_0$, where r_0 and τ_0 are the elementary spatial and temporal scales of the φ-torus. It is shown that c is invariant across all recursion levels d, since both scales grow as φ^d and their ratio cancels identically. The photon γ is identified with the ninth channel of the ternary operator matrix $\hat{O}$ — the trace $\mathrm{Tr}(\hat{O}_d)$, invariant under any basis transformation, which explains its masslessness, trans-level character, and speed c. Quantum entanglement and teleportation are explained as access to a single configuration in $\mathcal{H}$: entangled particles are not spatially separated but are cross-sections of a single object for which the concept of distance is undefined. It is shown that exceeding the limit c within ODTOE does not require "superluminal motion" — it is achieved through increasing coherence S, which expands the operator window Δn and thereby provides access to spatially remote sections of the world line without traversing intermediate configurations.

Keywords: light, speed of light, photon, reconfiguration, quantum teleportation, entanglement, coherence, ODTOE, configuration inertia, operator window, φ-torus, operator trace, ninth channel, U(3), actualization front.

I. INTRODUCTION. WHAT EXACTLY TRAVELS?

Twentieth-century physics established the dual nature of light: simultaneously a wave and a particle [2]. Yet the question of *what exactly* moves between source and receiver remains conceptually incomplete. Quantum electrodynamics (QED) describes the photon as a quantum of excitation of the electromagnetic field — not a point-like object but a probability amplitude for a transition between states [3]. Feynman emphasized that a photon "tries all paths simultaneously" [4], which makes it difficult to identify the photon with a localized object traveling along a trajectory.

The Observer-Dependent Theory of Everything (ODTOE) [1] offers a radical answer: the photon does not move — a reconfiguration occurs. Source and receiver are cross-sections of a single observation process in which the operator $\hat{O}$ projects successive configurations $R_n \in \mathcal{C}$ from the space of potential states $\mathcal{H}$. What is perceived as the "flight of a photon" is a chain of iterations $\Psi_n \to \Psi_{n+1} = \Phi(\Psi_n)$, in which excitation energy is sequentially actualized in intermediate configurations until it reaches the configuration "receiver is excited" [5, 6].

The goal of this paper is to formalize this interpretation, derive the speed of light c as the limiting reconfiguration rate, explain the nature of quantum entanglement and teleportation through the structure of $\mathcal{H}$, and demonstrate the mechanism by which a coherent observer can access information deemed "superluminal."

II. LIGHT AS RECONFIGURATION

II.1. The classical picture and its problems

In classical electrodynamics, light is an electromagnetic wave propagating in vacuum at $c = 299{,}792{,}458$ m/s. The wave carries energy but not matter. In quantum field theory, the photon is a field quantum created by the creation operator $a^\dagger$ and annihilated by the annihilation operator a [3]. Between creation and annihilation the photon is described by a propagator — a mathematical object summing amplitudes over all possible paths [4].

Remarkably, in QED the photon *has no trajectory* in the classical sense. Feynman's path integral sums contributions from all conceivable routes, including those passing through arbitrary points of spacetime. The "flight" of a photon is not the motion of an object but the evolution of a probability amplitude.

II.2. The reconfiguration interpretation

In ODTOE, reality R is generated by the observation operator:

$$R = \hat{O}(\Psi) \tag{A.1}$$

Configuration R is what the observer perceives as "the world now." A change of configuration is determined by iterations of the self-observation map $\Phi = \iota \circ \hat{O}$:

$$\Psi_{n+1} = \Phi(\Psi_n) \tag{II.1}$$

Consider the process of "photon emission" by atom A (source) and its "absorption" by atom B (receiver). In ODTOE this process is described as a sequence of configurations:

- R_0: "atom A is excited, atom B is in the ground state"
- $R_1, R_2, \ldots, R_{N-1}$: intermediate configurations
- R_N: "atom A is in the ground state, atom B is excited"

Each configuration R_k is generated by an iteration of Φ. The intermediate configurations $R_1, \ldots, R_{N-1}$ are what classical physics interprets as "a photon in flight." In reality these are successive actualizations from $\mathcal{H}$, not the displacement of an object through space.

The principal conclusion: the photon γ itself does not move at any recursion level d. As will be shown in Section VII.4, the photon is the trace of the operator $\hat{O}$, invariant under any basis transformation: $\gamma = \text{Tr}(\hat{O}_d)$ for all d. The trace does not belong to a specific level — it is identical on each of them. Therefore the photon has no need to "fly": it is already present wherever the observation operator is defined. What is registered as the "speed of light" is the actualization front velocity — the rate at which the boundary between potentiality $\mathcal{H}$ and actuality $\mathcal{C}$ advances through configuration space (detailed derivation — Section III).

II.3. Formula: a photon on the retina

Consider a concrete situation: a photon from a distant star reaches the retina of the eye. From the ODTOE standpoint:

$$R_{\text{star}\to\text{retina}} = \hat{O}_{\text{observer}}(\Psi_{\text{light}}) \tag{II.2}$$

The observer (eye + brain + consciousness) projects from $\mathcal{H}$ a configuration in which the photon has already been absorbed by the retinal rhodopsin. The "path" spanning billions of light-years is not a distance traversed by an object but a measure of the inertia $I(C)$ of the configuration separating the initial and final states.

III. THE SPEED OF LIGHT AS THE ACTUALIZATION FRONT VELOCITY

III.1. Toroidal geometry and level scales

The strange loop $\Phi = \iota \circ \hat{O}$ is realized on the φ-torus: a manifold T^2 with major radius R_d and minor radius r_d satisfying the self-similarity condition:

$$\frac{R_d}{r_d} = \varphi \quad \text{for all } d \tag{III.1}$$

where $\varphi = (1+\sqrt{5})/2$ is the golden ratio. When passing between adjacent recursion levels, both scales stretch by a factor of φ:

$$r_d = r_0 \cdot \varphi^d, \qquad R_d = \varphi \cdot r_d = r_0 \cdot \varphi^{d+1} \tag{III.2}$$

One iteration of Φ at level d completes a full traversal of the minor circle of the torus (cycle $\hat{O} \to \iota$); the characteristic duration of this cycle scales in the same way:

$$\tau_d = \tau_0 \cdot \varphi^d \tag{III.3}$$

III.2. Derivation of the invariance of c

The actualization front — the boundary separating potentiality $\mathcal{H}$ and actuality $\mathcal{C}$ — advances at each level d with velocity

$$c_d = \frac{r_d}{\tau_d} = \frac{r_0 \cdot \varphi^d}{\tau_0 \cdot \varphi^d} = \frac{r_0}{\tau_0} \tag{III.4}$$

The factor φ^d cancels identically. The central result follows:

$$\boxed{c \;=\; \frac{r_0}{\tau_0} \;=\; \text{const} \quad \text{for all } d} \tag{III.5}$$

The speed of light depends neither on the recursion level d, nor on the coherence S, nor on the dimensionality of the observed space. It is determined solely by the ratio of the elementary spatial and elementary temporal scales, which in turn are fixed by the geometry of the torus through the numbers π (curvature of the minor cycle: $L_{\text{minor}} = 2\pi r_0$) and φ (self-similarity: $R_0/r_0 = \varphi$). In other words, c is a structural characteristic of the φ-torus, not a property of the photon or the medium.

III.3. Relation to the inertia formula

Postulate P2 of ODTOE [1] relates the reconfiguration velocity to inertia:

$$v(C \to C') = \frac{\alpha}{I(C) + \varepsilon} \tag{P2.1}$$

Formulas (III.5) and (P2.1) agree under the identifications $\alpha \leftrightarrow r_0$ (spatial reconfiguration parameter — scale of the level) and $I_{\text{min}} + \varepsilon \leftrightarrow \tau_0$ (minimal inertia — elementary duration of one loop cycle). For a massless configuration (photon) the inertia is minimal: $I(C) = I_{\text{min}}$, and the velocity reaches the limit c. Thus the inertia formula (P2.1) is a *phenomenological expression* of the geometric identity (III.5).

III.4. Why the limit cannot be exceeded by sequential reconfiguration

Every actualized configuration possesses nonzero inertia: $I(C) \geq I_{\text{min}} > 0$. Physically this means that the act of projection $\hat{O} : \mathcal{H} \to \mathcal{C}$ irreversibly loses information in the kernel ker($\hat{O}$) [5], and each such act requires a minimal duration τ_0. The limit $c = r_0/\tau_0$ is absolute for sequential transitions in $\mathcal{C}$, but does not extend to $\mathcal{H}$, where the concept of distance is undefined (Section VI).

III.5. Relation to mass

Mass in ODTOE is a measure of excess inertia beyond the minimum:

$$m \propto I(C) - I_{\text{min}} \tag{III.6}$$

A massless configuration ($m = 0$) has $I(C) = I_{\text{min}}$, and the actualization front advances at the maximum velocity c. A massive configuration ($m > 0$) possesses additional inertia — its actualization front is slowed: $v < c$. The formula agrees with the relativistic relation $v < c$ for massive particles, but is derived from the geometry of the φ-torus.

III.6. Why c is a constant: Michelson–Morley

The invariance of c with respect to the reference frame is a consequence of the fact that r_0/τ_0 is determined by the structure of the φ-torus (π and φ), not by properties of the medium or the observer. The Michelson–Morley result [7] is explained without invoking the aether hypothesis: c does not depend on the motion of the observer because the ratio of the torus scales is identical in all reference frames. Coherence S affects the width of the operator window Δn (Section VI) but not c.

IV. QUANTUM ENTANGLEMENT: CROSS-SECTIONS OF A SINGLE OBJECT

IV.1. The problem of nonlocality

The experiments of Aspect [8] and subsequent Bell-inequality tests [9, 10] demonstrated unambiguously that entangled particles exhibit correlations inexplicable by local hidden variables. Measuring the spin of one particle instantaneously determines the spin of the other, regardless of the distance between them. The standard (Copenhagen) interpretation describes this as “nonlocal collapse of the wave function,” without providing a physical mechanism.

IV.2. Entanglement as a single configuration in $\mathcal{H}$

In ODTOE, entangled particles are not two separate objects but a single configuration in $\mathcal{H}$, observed (projected) into two “locations” in $\mathcal{C}$:

$$\Psi_{AB} \in \mathcal{H}, \quad R_A = \hat{O}_A(\Psi_{AB}), \quad R_B = \hat{O}_B(\Psi_{AB}) \tag{IV.1}$$

The element Ψ_{AB} is a *single object*. The concept of distance is defined in $\mathcal{C}$ (configuration space) but not in $\mathcal{H}$ (the space of potential states). Particles A and B are "far apart" in $\mathcal{C}$ yet identical as projections of a single element $\Psi_{AB} \in \mathcal{H}$.

Measurement — the act of observation $\hat{O}_A$ — fixes the projection of Ψ_{AB} onto $\mathcal{C}$ in a definite basis. Since Ψ_{AB} is one, fixing the projection at point A determines the projection at point B — not through signal transmission but through the identity of the object. Analogy: cutting a coin into two halves. Upon discovering "heads" on one half, the observer instantly knows the other is "tails," regardless of the distance. But unlike the classical analogy, in ODTOE the outcome is not predetermined before measurement — it is created by the act of observation.

IV.3. Non-separable entanglement entropy

Entanglement is measured by the von Neumann entropy of the reduced density matrix [11]:

$$S(\rho_A) = -\mathrm{Tr}(\rho_A \log \rho_A) > 0 \tag{IV.2}$$

Positive entropy means that subsystem A cannot be described independently of B. In ODTOE terms: the projection $\hat{O}_A(\Psi_{AB})$ contains less information than Ψ_{AB} as a whole. The "missing" information — correlations with B — is not lost but is contained in the full element $\Psi_{AB} \in \mathcal{H}$.

In [12] it was shown that the entanglement entropy between levels scales according to the golden proportion:

$$S(\rho_d) \propto \varphi^{-|d-d_0|} \tag{IV.3}$$

linking entanglement with the recursive structure of self-observation.

V. QUANTUM TELEPORTATION: RECONFIGURATION VIA $\mathcal{H}$

V.1. The standard teleportation protocol

The Bennett et al. protocol [13] allows one to "transfer" a quantum state from Alice to Bob without physically moving a particle:

1. Alice and Bob share an entangled pair.
2. Alice performs a joint measurement (Bell measurement) on her particle and the state to be teleported.

3. Alice transmits the measurement result to Bob (classical channel, $\leq c$).
4. Bob applies a unitary transformation and obtains an exact copy of the original state.

The paradox: the state is "transferred instantly," yet the basis information travels at $\leq c$. Is there a hidden mechanism here that permits circumventing the limitation?

V.2. Teleportation as navigation in $\mathcal{H}$

In ODTOE, teleportation is not a "transfer" of a state but a change of the projection $\hat{O}_B$:

$$R_B^{(\text{after})} = \hat{O}_B^{(\text{after})}(\Psi_{AB\otimes T}) \tag{V.1}$$

where T is the state to be teleported and $\otimes$ is the tensor product. Alice's Bell measurement modifies the overall configuration $\Psi_{AB\otimes T}$ (not destroying it in $\mathcal{H}$ but fixing its projection). The classical channel transmits to Bob the "instruction" of which projection to select from $\mathcal{H}$ in order to actualize state T on his side.

The speed-of-light restriction arises precisely at the instruction-transmission stage — that is, at the stage of reconfiguration in $\mathcal{C}$ (the space of actualized configurations). The state $\Psi_{AB\otimes T}$ itself exists in $\mathcal{H}$ as a single object, unconstrained by the spatiality of $\mathcal{C}$.

VI. EXCEEDING THE LIMIT c: EXPANDING THE OPERATOR WINDOW

VI.1. Two types of "velocity"

From the foregoing, a fundamental distinction follows:

1. **Actualization front velocity in $\mathcal{C}$:** bounded by $c = r_0/\tau_0$ (formula III.5) — the limiting rate of sequential configuration change, attained by massless configurations ($I = I_{\text{min}}$).
2. **Access to $\mathcal{H}$:** not bounded by c, since $\mathcal{H}$ is a non-spatial object. Distance in it is undefined; the concept of "velocity" is inapplicable.

Exceeding the limit c within ODTOE is not an acceleration of reconfiguration but an *expansion of access* to $\mathcal{H}$.

VI.2. The operator window Δn

In [14] the concept of the operator window was introduced — the number of self-observation iterations simultaneously accessible to the observer:

$$\Delta n \propto \frac{B^k}{D_0(1-S)} \tag{VI.1}$$

At standard coherence ($B < 1$, $S < 1$) $\Delta n \approx 1$ — the observer "sees" a single configuration. As coherence grows ($B \to 1$, $S \to 1$) the operator window expands, and the observer gains access to several iterations simultaneously.

Since the world line $W = \{\Psi_n^*\}_{n\in\mathbb{Z}}$ [14] contains configurations separated in $\mathcal{C}$-space, an expanded window $\Delta n \gg 1$ allows one to "see" spatially remote configurations without traversing intermediate ones — effectively, without limitation by the speed c.

VI.3. Coherence as the key to "superluminal" access

The stochastic noise $D(\eta) = D_0(1-S)$ [1] determines information loss at each iteration. As $S \to 1$ the noise tends to zero, and the projection $\hat{O} : \mathcal{H} \to \mathcal{C}$ becomes nearly isomorphic — the observer sees $\mathcal{H}$ "directly," without losses in the kernel $\ker(\hat{O})$. In this regime the concept of "distance" in $\mathcal{C}$ loses its restrictive force.

Formally: the access time to a configuration separated by N iterations, with the standard window ($\Delta n = 1$), is $T_{\text{access}} = N \cdot \tau_0$. With an expanded window ($\Delta n = N$) the access time is $T_{\text{access}} = \tau_0$ — one elementary duration, regardless of the "distance" N.

VI.4. Experimental correlates

ODTOE prediction: highly coherent quantum systems (Bose–Einstein condensates, superconductors) should exhibit correlations on scales exceeding the predictions of the standard decoherence theory. Experiments on quantum teleportation at record distances (143 km, La Palma island [15]; 1200 km, Micius satellite [16]) do not formally violate the c restriction (a classical channel is used), but demonstrate the stability of correlations in $\mathcal{H}$ at arbitrary scales in $\mathcal{C}$.

VII. THE NATURE OF THE ELECTROMAGNETIC FIELD IN ODTOE

VII.1. Charge as orientation in the loop

In [17] it was shown that electric charge is the orientation of action in the strange loop of self-observation:

$$q(X) = \text{sgn}(\langle X | e_{\hat{O}} \rangle) \tag{VII.1}$$

The electron ($q = -1$) is the direct action of the operator ($\hat{O} : \mathcal{H} \to \mathcal{C}$). The proton ($q = +1$) is the reverse action ($\iota : \mathcal{C} \to \mathcal{H}$). The neutron ($q = 0$) is the observer position. The photon $\gamma = \text{Tr}(\hat{O})$ is the operator trace, carrying no charge. Charge is determined by the orientation *within* the loop: $\hat{O} : \mathcal{H} \to \mathcal{C}$ (direct action) or $\iota : \mathcal{C} \to \mathcal{H}$ (reverse action). The trace, however, is invariant with respect to both orientations — it "sees" the loop as a whole without choosing a direction — and is therefore electrically neutral.

VII.2. The electromagnetic field as a coherence gradient

The electric field **E** is interpreted as the coherence gradient in configuration space:

$$\mathbf{E} \sim -\nabla_C S \tag{VII.2}$$

The magnetic field **B** is the curl of the helical dynamics:

$$\mathbf{B} \sim \nabla_C \times \mathbf{v}_\Phi \tag{VII.3}$$

where $\mathbf{v}_\Phi$ is the velocity of the iteration flow Φ in $\mathcal{C}$. Maxwell's equations, in this reading, express the self-consistency conditions of the operator $\hat{O}$ under changes of coherence in space and time [17].

VII.3. The ninth channel: deriving the photon from toroidal topology

VII.3.1. The 3×3 operator matrix

The ternary structure of ODTOE [1] prescribes three roles at each level d: observer O, operator $\hat{O}$, observed R. The operator $\hat{O}$ acts on the triple of color states (r, g, b), forming a $3 \times 3 = 9$-dimensional connection matrix [12]:

$$\hat{O}_d = \begin{pmatrix} \hat{O}_{rr} & \hat{O}_{rg} & \hat{O}_{rb} \\ \hat{O}_{gr} & \hat{O}_{gg} & \hat{O}_{gb} \\ \hat{O}_{br} & \hat{O}_{bg} & \hat{O}_{bb} \end{pmatrix} \tag{VII.4}$$

The nine elements of this matrix — nine communication channels — decompose into three groups:

Type	Count	Description
Off-diagonal	6	$(r \leftrightarrow g)$, $(r \leftrightarrow b)$, $(g \leftrightarrow b)$ — two directions each
Traceless diagonal	2	$\lambda_3 \propto \text{diag}(1, -1, 0)$, $\lambda_8 \propto \text{diag}(1, 1, -2)$
Trace	1	$\lambda_0 \propto \text{diag}(1, 1, 1) = \frac{1}{\sqrt{3}} I_3$

The algebra of $6+2=8$ traceless generators is $\mathfrak{su}(3)$; adding the ninth (the trace) extends it to $\mathfrak{u}(3)$:

$$\mathfrak{u}(3) = \mathfrak{su}(3) \oplus \mathfrak{u}(1), \qquad \dim \mathfrak{u}(3) = 3^2 = 9 \tag{VII.5}$$

In particle-physics language: the 8 traceless generators correspond to the 8 gluons of chromodynamics, carrying color charge. The ninth generator — the colorless singlet $(\bar{r}r + \bar{g}g + \bar{b}b)/\sqrt{3}$ — carries no color and therefore is not confined within level d.

VII.3.2. The photon as the trace of $\hat{O}$

The colorless singlet is the only channel "invisible" to the SU(3) color interaction. It has no color charge capable of confining it within a level, so it freely exits beyond d and becomes an inter-level operator. This channel is the photon γ:

$$\gamma = \mathrm{Tr}(\hat{O}_d) = \hat{O}_{rr} + \hat{O}_{gg} + \hat{O}_{bb} \tag{VII.6}$$

The key property of the trace: under any basis (unitary) transformation U of the matrix $\hat{O}$

$$\mathrm{Tr}(U\hat{O}_d U^{-1}) = \mathrm{Tr}(\hat{O}_d) \tag{VII.7}$$

The trace is invariant. This means that γ does not depend on the choice of basis (coordinate system, level d, observation scheme). The photon "sees" all levels of the infinite recursion identically — because at each of them it is one and the same invariant.

VII.3.3. Three properties of the photon derivable from (VII.6)

From the definition $\gamma = \mathrm{Tr}(\hat{O})$ the following properties follow:

(a) Masslessness. Mass in ODTOE is a measure of attachment to a level d (formula III.6). The trace, attached to no single level, possesses zero additional inertia: $I(\gamma) = I_{\min}$, $m_\gamma = 0$.

(b) Speed c. A massless configuration reconfigures at the maximum actualization front velocity $c = r_0/\tau_0$ (Section III.2). The photon does not "fly"; the actualization front advances through $\mathcal{C}$ at speed c, while γ is present wherever $\hat{O}$ is defined.

(c) Trans-level character. $\mathrm{Tr}(\hat{O}_d)$ is the same for all d. The photon is the only particle identical to itself at every recursion level: sub-photon = photon = super-photon. Therefore the photon acts as the connecting operator between levels.

VII.3.4. Photon and the Higgs field: actuality and potentiality

It is necessary to distinguish γ from H:

	Photon γ	Higgs field H
Status	9th operator channel (element of $\mathfrak{u}(1)$)	Substrate in which the 3×3 matrix unfolds
Mass	$m_\gamma = 0$	$m_H \approx 125$ GeV
Nature	Actuality: trace of the acting $\hat{O}$	Potentiality: background field $\mathcal{H}$ generating mass
Invariance	Basis: $\mathrm{Tr}(U\hat{O}U^{-1}) = \mathrm{Tr}(\hat{O})$	Gauge: $V(\Phi) = \lambda(\lvert\Phi\rvert^2 - v^2)^2$
Analogy	Moves of pieces on a chessboard	The chessboard itself

The field H is not an operator channel but the medium in which the operator exists. H sets the vacuum expectation value $\langle\Phi\rangle = v$, endowing with mass those particles associated with matrix elements (W, Z bosons). The photon — the matrix trace — remains massless because the trace commutes with any gauge transformation and does not interact with the Higgs condensate [23].

Electromagnetic $U(1)$ thus has a dual origin in ODTOE: (a) topological — from the fundamental group of the torus $\pi_1(S^1) = \mathbb{Z}$, and (b) algebraic — as the trace of the ternary matrix $\hat{O}$, the 9th generator of $\mathfrak{u}(3)$. The coincidence of two independent derivation paths confirms the self-consistency of the theory.

VII.4. Wave or particle?

Wave–particle duality is resolved in ODTOE in a natural way. The photon is not an object but an act of reconfiguration. When an experiment is designed to observe a "particle" (the detector registers a discrete event), the operator $\hat{O}$ projects a discrete configuration — a "detector click." When the experiment is designed to observe a "wave" (an interference pattern), the operator $\hat{O}$ projects a probability distribution over a set of configurations. The result depends on the observer (formula A.1) — which is precisely why the double-slit experiment [2] yields different patterns in the presence and absence of a detector.

VIII. KOZYREV'S EXPERIMENTS AND ACCESS TO REMOTE CONFIGURATIONS

VIII.1. Three stellar positions

N. A. Kozyrev [18], while observing stars, detected signals corresponding to three positions: past (visible), present (true), and future (predicted). In standard physics this result has received no explanation. In ODTOE it is interpreted through the concept of the world line $W = \{\Psi_n^*\}_{n\in\mathbb{Z}}$ [14]: the three positions are three cross-sections of the star's world line accessible through the expanded operator window of the detector (torsion balance):

- R_{past}: cross-section at $n = n_0 - \Delta n_{\text{light}}$ (light that arrived from the star)

- R_{present}: cross-section at $n = n_0$ (true position)
- R_{future}: cross-section at $n = n_0 + \Delta n_{\text{light}}$ (extrapolation)

VIII.2. Access mechanism

Access to the present and future positions does not require "superluminal" signal transmission. The star's world line exists in $\mathcal{H}$ as a single object. A detector with sufficiently high sensitivity (low $D(\eta)$) can project cross-sections of W at $n \neq n_0$, expanding Δn through minimization of stochastic noise.

IX. EXPERIMENTALLY TESTABLE CONSEQUENCES

1. *Distinguishing the fundamental c from the effective velocity v_{eff}.* The fundamental actualization front velocity $c = r_0/\tau_0$ (formula III.5) is invariant: it is determined by the geometry of the φ-torus and depends neither on the level d nor on the coherence S. At the same time, in media with high coherence (Bose–Einstein condensate, superconductor) the *effective group velocity* v_{eff} can differ substantially from c. The slowing of light in a Bose–Einstein condensate to 17 m/s, demonstrated by Hau et al. [19], is a change in v_{eff}, not in c: the medium modifies the configuration inertia $I(C) > I_{\text{min}}$, increasing the denominator in formula (P2.1), while the limit $c = r_0/\tau_0$ itself remains unchanged. ODTOE predicts that systematic measurement of v_{eff} in media with varying coherence S will allow experimental verification of the dependence $v_{\text{eff}}(S)$ at constant c.
2. *Entangled-particle correlations and coherence.* ODTOE predicts that the degree of Bell-inequality violation correlates with the coherence S of the experimental setup. Systematic comparison of CHSH parameter values with estimates of the setup coherence S is a direction for testing.
3. *Reproduction of Kozyrev's observations.* The three stellar positions can be re-examined with modern bolometers whose sensitivity exceeds that of Kozyrev's equipment [18] by three orders of magnitude.
4. *Quantum teleportation and channel capacity.* If teleportation is navigation in $\mathcal{H}$, the capacity of the quantum channel should depend not only on the classical channel but also on the coherence of the entangled pair. Degradation of entanglement (decoherence) in ODTOE is formalized as growth of $D(\eta)$, which reduces Δn.

X. DISCUSSION AND LIMITATIONS

1. *Configuration inertia.* The parameter $I(C)$ has no direct empirical definition outside quantum-mechanical systems. The identification $m \propto I(C) - I_{\text{min}}$ (formula III.6) is consistent with relativistic mechanics. The correspondence

$\alpha \leftrightarrow r_0$ and $I_{\min} + \varepsilon \leftrightarrow \tau_0$ (Section III.3) links the inertia parameter to the elementary scales of the φ-torus, but this link requires independent experimental verification.

2. *Information transfer.* ODTOE does not predict superluminal transfer of *information* in the operational sense. Expanding Δn grants access to correlations, but not to controlled transmission of bits faster than c. The no-cloning theorem [20] and the no-signaling theorem for entanglement [21] remain in force at the $\mathcal{C}$ level.

3. *Status of $\mathcal{H}$.* The space of potential states $\mathcal{H}$ is not an observable object — it is in principle unobservable within a single projection $\hat{O}$. Its ontological status is analogous to that of the wave function in standard quantum mechanics: mathematical object or element of reality — a question open for discussion [22].

4. *Kozyrev's experiments.* Kozyrev's results have not been reproduced by independent groups with modern equipment. Until such experiments are conducted, the interpretation remains hypothetical.

5. *Limits of analogy.* The analogy "photon = reconfiguration" does not claim to replace the QED formalism, which successfully predicts the anomalous magnetic moment of the electron to a precision of 10^{-12} [3]. ODTOE offers a metatheoretical framework in which QED is a particular configuration at specific values of S and d [6].

XI. CONCLUSION

Light within ODTOE is not an object flying through the void but a sequence of actualizations generated by iterations of the self-observation map Φ. The photon γ is identified with the trace of the ternary operator matrix: $\gamma = \mathrm{Tr}(\hat{O}_d)$ — the ninth channel of $\mathfrak{u}(3)$, free from the color confinement of $\mathfrak{su}(3)$. The invariance of the trace under basis transformations explains three fundamental properties of the photon: masslessness, speed c, and trans-level character. The speed of light $c = r_0/\tau_0$ is the actualization front velocity, determined by the geometry of the φ-torus (π and φ) and invariant across all recursion levels d, since both scales grow as φ^d and their ratio cancels identically. This limit is absolute for sequential transitions in $\mathcal{C}$ but does not extend to $\mathcal{H}$, in which the concept of distance is undefined.

Quantum entanglement is not "spooky action at a distance" (Einstein) but identity of the object: entangled particles are cross-sections of a single configuration in $\mathcal{H}$, projected into different points of $\mathcal{C}$. Teleportation is navigation through $\mathcal{H}$, limited by the classical channel only at the instruction-transmission stage in $\mathcal{C}$.

Exceeding the limit c is achieved not by accelerating reconfiguration but by expanding the operator window Δn through increasing coherence S. A coherent observer ($S \to 1$) minimizes stochastic noise, expanding access to spatially remote cross-sections of the world line. This mechanism is formally consistent with no-signaling theorems, since expanding Δn grants access to correlations rather than to controlled information transfer.

Four directions for experimental verification are proposed: dependence of the effective speed of light on medium coherence, correlation of Bell-inequality violation with setup coherence, reproduction of Kozyrev's observations, and investigation of quantum-channel capacity as a function of entangled-pair coherence.

CONFLICT OF INTEREST

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