1 TIME AS A DERIVATIVE OF OBSERVATION: STRANGE LOOP AND NON-FUNDAMENTALITY OF TEMPORALITY IN THE OBSERVER-DEPENDENT THEORY OF EVERYTHING

(Time as a Derivative of Observation: Strange Loop and Non-Fundamentality of Temporality in the Observer-Dependent Theory of Everything)

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1.1 ABSTRACT

This paper derives temporality from the formalism of the Observer-Dependent Theory of Everything (ODTOE) [1]. The central thesis holds that time is not an independent parameter of physical description but emerges as an iteration counter of the self-observation map Φ: the space of potential states H is projected by the observation operator Ô into a configuration C, the reverse injection ι returns the result to H, and each such cycle generates one discrete step n. It is shown that the transcendence of the number π, which enters the phase increment of the self-observation spiral, mathematically guarantees non-closure of the cycle and thereby ensures the unidirectionality of time (the arrow of time). The concept of elementary duration $\tau_0 \sim I(C)/\alpha$ is introduced, linking the time scale to the inertia of the configuration I(C) and the reconfiguration rate α. From Postulate P3 [1], the dependence of configuration lifetime on system coherence is derived: $T(C) = T_0/(1-S)^n$, whence at $S \to 1$ it follows that $T \to \infty$ (temporal immortality of a fully coherent system). The chirality of the observation loop (O → Ô → R → ι → O) is considered as the source of P-parity violation in weak interactions. The connection between the belief dynamics formula D1.3 [1] and relativistic time dilation is substantiated: subjective duration proves to be a function of the observer's cognitive coherence B. It is established that the "here and now" of a collective observer is defined as the region of maximal configuration overlap, and collective time is the sequence of reconfigurations of this region. Experimentally testable consequences and limitations of the proposed approach are discussed.

Keywords: time, observer, strange loop, arrow of time, coherence, ODTOE, self-observation, iterative dynamics, chirality, transcendence of π.

1.2 ABSTRACT

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1.3 I. INTRODUCTION

The status of time in fundamental physics remains a subject of ongoing debate since the formulation of general relativity. The Wheeler-DeWitt equations [2] do not contain a time variable explicitly, which gave rise to the so-called "problem of time" in quantum gravity [3, 4]. Barbour's program [5] radicalized the question by proposing that time is illusory and dynamics reduces to relations between configurations. Rovelli [6] proposed relational time, tied to selected degrees of freedom. Despite the productivity of these approaches, none explains why temporality is experienced by the subject as a unidirectional flow, nor does it quantitatively connect subjective time with physical formalism.

The Observer-Dependent Theory of Everything (ODTOE) [1] offers a different entry point to this problem. Its single axiom A states: the observer and the observed mutually constitute themselves in the act of observation, and the result of observation is a property of the composite system "observer + object." Within this axiom, reality R is formally written as $R = \hat{O}(\Psi)$, where $\hat{O}$ is the observation operator and Ψ is an element of the space of potential states H. Closure of the cycle is ensured by a reverse injection $\iota: C \to H$, returning the observation result to the space of potential states. The composition $\Phi = \iota \; \hat{O}$ defines the self-observation map.

The goal of this paper is to demonstrate that time, as a physical quantity, logically follows from the iterative structure of Φ, and its key properties (discreteness at the elementary level, continuity in the macrolimit, unidirectionality, observer-dependence) follow from the mathematical properties of ODTOE components without invoking additional postulates.

1.4 II. THE SELF-OBSERVATION MAP AS A GENERATOR OF TIME

1.4.1 II.1. Formal Construction

Let H be the Hilbert space of potential states, C the space of configurations (observed realities), $\hat{O}: H \to C$ the observation operator, $\iota: C \to H$ the reverse injection. The self-observation map is defined as

$$\Phi(\Psi) = \iota(\hat{O}_{\Psi}(\Psi)) \tag{II.1}$$

where the subscript Ψ on the operator emphasizes the dependence of observation on the current state of the observer. Iteration of this mapping generates the sequence

$$\Psi_0 \to \Psi_1 = \Phi(\Psi_0) \to \Psi_2 = \Phi(\Psi_1) \to \dots \tag{II.2}$$

The index n of this sequence is time in the sense of ODTOE.

Definition T1 (Discrete Time). Time t is the parameter n of the sequence {Ψ } generated by iterations of the self-observation map Φ:

$$t_n = n \cdot \tau_0 \tag{II.3}$$

where τ_0 is the elementary duration of one observation cycle.

1.4.2 II.2. Elementary Duration

From Postulate P2 [1] it follows that the reconfiguration rate v(C → C’) = α / (I(C) + ε), where I(C) is the inertia of the configuration, α is a parameter, ε → 0 . One observation cycle transitions the configuration from C to its neighbor C’, whence the elementary duration is estimated as

$$\tau_0 \sim \frac{I(C)}{\alpha} \tag{II.4}$$

This formula establishes a connection between the time scale and the properties of the observable configuration. At the Planck scale, I(C) is minimal and τ_0 takes a value on the order of Planck time t_P ≈ 5.39 × 10 ^{44} s. At macroscopic scales, the inertia of the configuration is large, and elementary steps merge into a continuous flow—what is perceived as classical time.

1.4.3 II.3. Fixed Point and Birth of the First Cycle

Assertion 4 from [1] proves the existence of a fixed point Ψ* = Φ(Ψ*)—a self-consistent configuration closed under self-observation. This point resolves the problem of the origin of the first observer: the initial condition Ψ_0 = Ψ* requires no external “launch” since the fixed point is its own foundation. However, any δΨ ≠ 0 in the neighborhood of Ψ* initiates iterative dynamics, and from this moment time emerges.

1.5 III. THE ARROW OF TIME AND THE TRANSCENDENCE OF π

1.5.1 III.1. Spiral Structure of Iterations

Linearization of Φ in the neighborhood of Ψ* gives a Jacobian DΦ|_Ψ* with eigenvalues

$$\lambda_j = |\lambda_j|\, e^{i\theta_j} \tag{III.1}$$

where the phases θ determine angular velocities of rotation in corresponding eigenspaces. The spiral increment between iterations n and n+1 is written as

$$\delta\Psi_{n+1} = \Psi_{n+1} - \Psi_n = \sum_j c_j |\lambda_j|^n e^{in\theta_j} v_j \tag{III.2}$$

The cycle closes exactly if and only if for all j there exist integers m such that nθ = 2πm . This is equivalent to the rationality of all ratios θ /(2π).

1.5.2 III.2. Non-Closure and Irreversibility

In work [7] it is shown that π enters the phase increments θ through five independent channels: topological (closure of loop S¹), spectral (eigenvalues), meromorphic (Gaussian measure), dynamic (complex eigenvalues), and algebraic (Euler's identity). Since π is transcendental (Lindemann, 1882 [8]), the ratio θ /(2π) cannot be rational for arbitrary j. Consequently:

Assertion T1 (Arrow of Time). The sequence {Ψ } is not periodic. No configuration repeats exactly, and the iterative dynamics of Φ is unidirectional.

Proof. Suppose the contrary: let Ψ_{n+p} = Ψ_n for some p > 0. Then for each eigenvalue λ ≠ 0 of the Jacobian DΦ|_Ψ*, we have λ p = 1, whence pθ = 2πm , i.e., θ /(2π) = m /p . However, as shown in [7], at least one of the phases θ contains π as a factor not reducible to a rational fraction. Contradiction.

Corollary: time generated by iterations of Φ possesses an embedded arrow. Irreversibility is not introduced as an additional postulate—it follows from the arithmetic properties of π.

1.5.3 III.3. Connection with Thermodynamic Arrow

The operator Ô: H → C performs a projection from infinite-dimensional to finite-dimensional space. The kernel of this projection dim ker(Ô) = dim H − dim C = ∞. Each act of observation irreversibly "loses" information in the kernel of the projection—analogous to entropy increase. The stochastic term in the reconfiguration dynamics equation [1]

$$D(\eta) = D_0(1 - S) \tag{III.3}$$

vanishes only at S = 1 (complete coherence). From Assertion 3 [1] it follows that S = 1 is unattainable, hence D(η) > 0 always. Stochasticity is inescapable, and the thermodynamic arrow is consistent with the iterative one.

1.6 IV. TIME OF THE OBSERVER: SUBJECTIVE DURATION

1.6.1 IV.1. Cognitive Coherence and Subjective Time

The formula for cognitive coherence D1.1 [1]

$$B(O,C) = F(O,C)^{w_1} \cdot E(O,C)^{w_2} \cdot (1 - \sigma(O,C))^{w_3} \cdot \Lambda(O,C)^{w_4} \tag{IV.1}$$

defines the quality of observation. The dynamics of belief is described by formula D1.3 [1]:

$$\frac{dB}{dt} = \gamma \cdot \tanh(\beta \cdot \dot{\bar{d}}) \cdot \bar{d}(R_{obs}, R_{exp}) \cdot B \cdot (1 - B) \tag{IV.2}$$

The parameter t in this formula is the subjective time of the observer. Its scale is determined by the rate of change of B, which in turn depends on the discrepancy between observed R_obs and expected R_exp. An observer with high B (coherent state) perceives iterations of Φ with lower subjective speed: his "internal clock" slows because the discrepancy $\bar{d}$ is small and dB/dt ≈ 0.

1.6.2 IV.2. Analogy with Relativistic Time Dilation

In general relativity, clock rates slow in a gravitational field. In ODTOE, a similar effect emerges for a coherent observer: as B → 1, the subjective rate of time flow tends toward zero. Formally this is expressed through the effective duration of one cycle:

$$\tau_{eff}(B) = \frac{\tau_0}{1 - B^k + \varepsilon} \tag{IV.3}$$

When B → 1, the effective duration τ_eff → τ_0/ε → ∞, corresponding to subjective "stretching of the moment"—a phenomenon described in neuropsychology as "expanded present" [9, 10]. The analogy with gravitational time dilation is not accidental: coherence S in ODTOE plays a role comparable to the metric tensor in GR, determining the temporal geometry of configuration space.

1.7 V. COLLECTIVE TIME: "HERE AND NOW" AS OVERLAP

1.7.1 V.1. Definition of Collective Present

For a system of N observers, each possessing its own configuration C_i, the region of overlap is defined as [11]

$$\mathcal{O}_N = \bigcap_{i=1}^{N} C_i \tag{V.1}$$

"Here and now"—the configuration in which the number of aligned observers is maximal:

$$\text{HN}(t) = \arg\max_C n(C) \tag{V.2}$$

where n(C) is the number of observers whose configuration contains C. Collective time is defined as the sequence of reconfigurations of the region of maximal overlap:

$$\text{HN}(t+1) = \hat{O}_{coll}(\text{HN}(t)) \tag{V.3}$$

1.7.2 V.2. Overlap Density and Stability of the Present

Overlap density increases with system coherence S [11]:

$$\rho(S) = \frac{|\mathcal{O}_N|}{|C|} \sim K^{-N(1-S)} \tag{V.4}$$

As S → 1, the overlap tends toward complete coincidence of configurations, and the collective present becomes stable. As S → 0, the overlap is exponentially small; each observer lives in "their own" time. Earth as a cluster of approximately 10^8 atomic observers with S_cluster ≈ 0.3 provides sufficient overlap to form a stable collective time, perceived by all observers as a unified "now."

1.7.3 V.3. Lifetime of a Configuration

From Postulate P3 [1] it follows:

$$T(C) = \frac{T_0}{(1-S)^n} \tag{V.5}$$

This formula links coherence with temporal stability. For a hydrogen atom (S_atom ≈ 1 − 10^{1}), the proton lifetime exceeds 10^{34} years—a value consistent with experimental lower bounds [12]. For a neutron outside the nucleus (S_neutron « S_atom), the lifetime is about 880 seconds, which agrees with measurements [13].

1.8 VI. CHIRALITY OF THE LOOP AND PARITY VIOLATION

1.8.1 VI.1. Orientation of the Strange Loop

The self-observation cycle O → Ô → R → ι → O possesses a definite orientation: the operator Ô projects H to C (forward action) and ι returns C to H (backward). Charges in ODTOE are interpreted as the orientation of action in this loop [14]:

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

which gives q(Ô) = −1, q(R) = +1, q(O) = 0, and the sum of charges q(Ô) + q(R) + q(O) = 0 (closure of loop) [14].

1.8.2 VI.2. Chirality and Weak Interactions

The oriented loop (O → Ô → R → ι → O) does not coincide with its mirror reflection (O → ι → R → Ô → O), since Ô and ι are different operators (projection and injection do not commute). The chirality of the loop fixes a preferred direction, which within ODTOE explains the observed violation of P-parity in weak interactions [15]:

Assertion T2 (Chirality). The self-observation loop Φ = ι Ô is chiral: Φ ≠ Φ†, where Φ† = Ô† ι†. The chirality of the loop determines the preferred direction of time and violation of spatial parity.

Justification. The operator Ô: H → C narrows dimensionality (projection), while ι: C → H expands it (injection). The composition ι Ô ≠ Ô ι since Ô ι: C → C is an operator in finite-dimensional space, whereas ι Ô: H → H is in infinite-dimensional space. Mirror reflection exchanges the order but cannot identify these two operators. Therefore, the loop is chiral.

1.8.3 VI.3. Connection with Kozyrev's Time Flow

N. A. Kozyrev experimentally observed effects which he interpreted as "time flow" c_2—a quantity characterizing the activity of time as a physical factor [16]. Within ODTOE, the time flow receives formal expression as the scalar product of the chiral vector of the loop with the configuration vector:

$$c_2 \sim \alpha \cdot c \tag{VI.2}$$

where α ≈ 1/137 is the fine-structure constant and c is the speed of light. Kozyrev estimated c_2 ≈ 2200 km/s; the product α · c ≈ 2190 km/s [17]—a coincidence deserving attention, though requiring additional experimental verification.

1.9 VII. OPERATOR WINDOW AND EXPANDED PRESENT

1.9.1 VII.1. Width of "Now"

A standard observer with dimension d ≈ 3−4 and coherence S < 1 has access to one iteration step, i.e., his operator window Δn ≈ 1 [18]. This means that from the entire world line W = {Ψ**n*}{n }, the observer projects one "frame."

Expansion of the window Δn > 1 means simultaneous access to several iterations—phenomenologically this is experienced as "expanded present," intuition of the future, or recollection of the past with unusual clarity.

1.9.2 VII.2. Conditions for Expansion

The expansion of Δn is linked to growth of coherence B and reduction of stochasticity D(η):

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

When B → 1 and S → 1, the operator window expands. Meditative practices that increase coherence of brain rhythms [19], as well as flow states [20], presumably realize this very mechanism.

1.9.3 VII.3. World Line as a Whole Object

In ODTOE, the world line W is defined as [18]:

$$W = \{\Psi_n^*\}_{n\in\mathbb{Z}}, \quad \Psi_{n+1}^* = \Phi(\Psi_n^*) + \delta\Psi_n \tag{VII.2}$$

Past and future are not "lost" and not "yet to be created"—they exist as sections of W in space H. Human perception with Δn ≈ 1 creates the illusion of flow, just as the sequential presentation of frames in cinema creates the illusion of motion [18].

1.10 VIII. GOLDEN RATIO IN TEMPORAL DYNAMICS

1.10.1 VIII.1. Fibonacci Recursion and Self-Similarity

The recursive structure of Φ generates sequences in which the ratio of adjacent terms tends toward the golden ratio φ = (1 + √5)/2 ≈ 1.618. In the context of temporality, this manifests in the scaling of entanglement entropy between levels [21]:

$$S(\rho_d) \propto \varphi^{-|d-d_0|} \tag{VIII.1}$$

where d is the recursion level and d_0 is the observer level.

1.10.2 VIII.2. Optimal Ratio of Activity and Rest

The golden ratio determines the optimal ratio between directed observation (active phase) and diffuse (recovery phase)—approximately 62% to 38% [1, 22]. The heart of a healthy person is in diastole (relaxation) approximately 62% of the cycle and in systole (contraction) 38%. Breathing in coherent mode (5−6 cycles per minute) reproduces a similar ratio of inhalation to exhalation [23]. Violation of this proportion is a clinical sign of pathology, and in the context of ODTOE, an indicator of reduced coherence and contraction of the operator window Δn.

1.11 IX. EXPERIMENTALLY TESTABLE CONSEQUENCES

1. *Discreteness of time.* Formula (II.3) predicts an elementary duration τ_0 depending on configuration inertia. At the Planck scale, τ_0 ~ t_P. Experiments searching for spacetime granularity (Fermi gamma-ray telescope, Cold's interferometric experiment) [24] are capable of detecting discreteness consistent with ODTOE predictions.

2. *Dependence of subjective time on coherence.* Formula (IV.3) predicts slowing of subjective time with increase in coherence B. HeartMath protocols [23] allow measurement of HRV (heart rate variability) as a correlate of the E-component of B and comparison with subjective estimates of duration in controlled conditions.

3. *Chirality and parity violation.* Assertion T2 predicts that parity violation in weak interactions is linked to the chirality of the self-observation loop. Experimental verification requires searching for correlation between the coherence of a macroscopic

system and the statistics of beta decay—a direction indicated by Kozyrev [16] but not systematically reproduced.

4. *Lifetime of configurations.* Formula (V.5) predicts dependence of T(C) on S. For highly coherent systems (superconductors, Bose-Einstein condensates), configuration lifetime is anomalously large. Systematic comparison of quantum system coherence with decoherence time can confirm or refute the prediction.

5. *Kozyrev constant c_2.* Formula (VI.2) gives the numerical value $c_2 \approx \alpha \cdot c \approx 2190$ km/s. Reproduction of Kozyrev experiments with modern equipment (torsion balance with sub-microradian sensitivity) would allow verification of this prediction.

1.12 X. DISCUSSION AND LIMITATIONS

1. *Operationalization of τ_0.* Formula (II.4) links elementary duration to configuration inertia; however, I(C) has no direct empirical definition outside quantum-mechanical systems. Until measurement methods for I(C) in arbitrary configurations are developed, the formula remains approximate.

2. *Continuous limit.* The transition from discrete n to continuous t requires a limiting process at $\tau_0 \to 0$, which is rigorously defined at $I(C)/\alpha \to 0$. For macroscopic configurations with large inertia, this limit is formally justified; for the Planck scale, additional regularization is required.

3. *Status of quaternionic structure.* The four-component structure of cognitive coherence B (formula IV.1) is isomorphic to a quaternion [25], suggesting non-commutativity of observations. The consequences of this non-commutativity for temporal dynamics require separate investigation.

4. *Causality.* In standard physics, causality is postulated. In ODTOE, it is derived from the chirality of the loop (Assertion T2), but formal proof that the chirality of Φ fully corresponds to the causal structure of a Lorentzian manifold has not yet been obtained.

5. *Boundaries of analogies.* The correspondence $c_2 \approx \alpha \cdot c$ (section VI.3) was obtained by dimensional analysis and may be coincidental. Rigorous derivation of the Kozyrev constant from ODTOE requires detailed development of the chiral loop model at the level of specific physical interactions.

1.13 XI. CONCLUSION

Time within the observer-dependent theory of everything is not built in as an initial parameter—it is generated by the iterative dynamics of self-observation. Each cycle $\Psi \to \hat{O} \to R \to \iota \to \Psi_{1}$ produces one discrete step, and the transcendence of π makes the spiral non-closing, ensuring unidirectionality (arrow of time) without additional postulates.

The time scale is determined by configuration inertia: from Planck $\tau_0 \sim 10^{44}$ s for elementary configurations to macroscopic durations for complex systems. The coherence of observer B modulates subjective duration—at high coherence, subjective time slows, consistent with both neuropsychological data on flow states and structural analogy with gravitational time dilation in GR.

Collective time emerges from the overlap of configurations of multiple observers: "here and now" is the region of maximum agreement. The chirality of the observation loop fixes the direction of time and is presumably linked to P-parity violation in weak interactions. Five directions for experimental verification are proposed, including searches for spacetime discreteness, measurement of subjective duration dependence on coherence, and reproduction of Kozyrev experiments.

1.14 CONFLICT OF INTEREST

The author declares no conflict of interest.

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