TIME, SPIRALITY AND CHIRALITY IN THE OBSERVER-DEPENDENT THEORY OF EVERYTHING (ODTOE)

Emergent Temporality and Comparison with N. A. Kozyrev's Causal Mechanics

(Время, спиральность и хиральность в наблюдатель-зависимой теории всего (ODTOE):
Эмерджентная темпоральность и сопоставление с причинной механикой Н. А. Козырева)

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ABSTRACT

Within the Observer-Dependent Theory of Everything (ODTOE), the origin of time, its directionality (arrow), and the chirality of physical processes are investigated as consequences of the spiral dynamics of the self-observation loop. It is shown that the iterative sequence of the mapping $\Phi\colon \Psi_{n+1} = \Phi(\Psi_n)$ generates a discrete precursor of time, while the structural unattainability of full coherence $S = 1$ (Proposition 3 [1]) ensures the irreversibility of this sequence. The transcendence of π [2] guarantees that the spiral increment $\delta\Psi$ does not vanish at any finite step, producing an ineliminable arrow of time. The traversal direction of the loop $O \to \hat{O} \to R \to \iota \to O$ fixes the left-handedness of the spiral, consistent with the experimentally established violation of spatial parity in weak interactions (Wu experiment, 1957 [3]) and with observed neutrino oscillations [26, 27]. A systematic comparison with N. A. Kozyrev's causal mechanics (1958) [4, 5], which independently postulated active properties of time, the connection between the course of time and cause–effect asymmetry, and the role of rotation in manifesting temporal forces, is carried out. Points of structural correspondence and principal divergences are identified. Limitations and verification directions are discussed.

Keywords: time, chirality, spiral dynamics, arrow of time, causal mechanics, Kozyrev, ODTOE, observer, strange loop, parity violation, self-reference.

АННОТАЦИЯ

В рамках наблюдатель-зависимой теории всего (ODTOE) исследуется

происхождение времени, его направленности (стрелы) и хиральности физических процессов как следствий спиральной динамики петли самонаблюдения. Показано, что итерационная последовательность отображения $\Phi\colon \Psi_{n+1} = \Phi(\Psi_n)$ порождает дискретный прообраз времени, а структурная недостижимость полной когерентности $S = 1$ (Утверждение 3 [1]) обеспечивает необратимость этой последовательности. Трансцендентность числа π [2] гарантирует, что спиральное приращение $\delta\Psi$ не обращается в нуль ни при каком конечном шаге, порождая неустранимую стрелу времени. Направление обхода петли $O \to \hat{O} \to R \to \iota \to O$ фиксирует левую хиральность спирали, что согласуется с экспериментально установленным нарушением пространственной чётности в слабом взаимодействии (эксперимент Ву, 1957 [3]) и с наблюдаемыми нейтринными осцилляциями [26, 27]. Проведено систематическое сопоставление полученных результатов с причинной механикой Н. А. Козырева (1958) [4, 5], которая независимо постулировала активные свойства времени, связь хода времени с причинно-следственной асимметрией и роль вращения в проявлении темпоральных сил. Установлены точки структурного соответствия и принципиальные расхождения двух подходов. Обсуждены ограничения и направления верификации.

Ключевые слова: время, хиральность, спиральная динамика, стрела времени, причинная механика, Козырев, ODTOE, наблюдатель, странная петля, нарушение чётности, самореференция.

I. INTRODUCTION

1.1. The Problem of Time in Theoretical Physics

The status of time in physics has remained an unresolved problem for centuries. Newtonian mechanics accepts absolute time as an external uniformly flowing parameter [6]. Special relativity unifies time with space into a four-dimensional continuum, admitting clock retardation under relative motion [7]. General relativity geometrizes time, incorporating it into a dynamic metric deformed by the energy-momentum distribution [8]. Quantum mechanics retains time as an external parameter without associating an operator to it, which generates a fundamental asymmetry of the formalism—the problem of time in quantum gravity [9].

Yet none of the listed constructions answers the question of the origin of time. Why does time exist? Why is it directed? Whence the arrow of time? The thermodynamic answer (the second law, entropy growth) presupposes the existence of time and explains only its asymmetry [10]. The cosmological answer (special initial conditions, the low initial entropy hypothesis) transfers the problem to the boundary conditions of the Universe [11].

1.2. An Alternative Approach: Time as an Active Entity

In 1958 N. A. Kozyrev proposed a fundamentally different position: time possesses its own physical properties that manifest in cause–effect relations [4]. Kozyrev introduced the quantity $c_2 = \Delta x/\Delta t$—the course of time, having the dimension of velocity and characterizing the speed of transition from cause to effect in an elementary cause–effect link. On the basis of experiments with gyroscopes he obtained the estimate $c_2/\pi \approx 700$ km/s, whence $c_2 \approx 2200$ km/s $\approx \alpha \cdot c$, where $\alpha \approx 1/137$ is the fine-structure constant and c is the speed of light [5, 12]. Kozyrev postulated that the course of time generates additional asymmetric forces in rotating systems that violate the mirror symmetry of cause and effect.

Kozyrev's causal mechanics did not gain acceptance in the academic community: the commissions of the Pulkovo Observatory in 1960 and 1967 concluded that the observed effects were at the limit of measurement accuracy [13]. At the same time, the Japanese researchers Hayasaka and Takeuchi (1989) discovered analogous effects of gyroscope weight change upon rotation [14], and Rokityansky (2012) pointed out the coincidence of the results of Kozyrev, Hayasaka–Takeuchi, and data from the Mars Orbiter Laser Altimeter (MOLA) on the north–south asymmetry of planets [15].

1.3. The ODTOE Position: Time as a Derivative of Self-Observation

The Observer-Dependent Theory of Everything (ODTOE) [1] proposes a third position, distinct both from Kozyrev's substantival concept and from the standard relational approach: time is neither fundamental nor substantival but arises as a by-product of the iterative dynamics of the self-observation loop. Each act of observation—one revolution of the loop—generates a discrete "tick" of time. The arrow of time is set not thermodynamically but structurally—by the irreversibility of projecting the infinite-dimensional space of potential states $\mathcal{H}$ onto the finite-dimensional configuration space $\mathbb{C}$.

The present work pursues three goals: (a) to formally derive the origin of time and its properties from the axiomatics of ODTOE; (b) to establish the connection between the chirality of the self-observation loop and the experimentally observed violation of spatial parity; (c) to carry out a systematic comparison with Kozyrev's causal mechanics, identifying structural parallels and principal divergences.

1.4. Structure of the Paper

Section II reproduces the necessary elements of the formalism. Section III derives discrete, spiral, and continuous time from the iterative dynamics. Section IV investigates the chirality of the loop and its connection with experimental data on P-parity violation. Section V presents the main provisions of Kozyrev's causal mechanics in a form amenable to direct comparison. Section VI carries out this comparison. Section VII discusses the duality of the neutrino and time. Section VIII discusses limitations. Section IX formulates conclusions.

II. NECESSARY ELEMENTS OF THE ODTOE FORMALISM

For self-sufficiency of the exposition we reproduce the key definitions and formulae of ODTOE [1, 2, 16].

Axiom (A). The observer constitutes the observed; the result of any observation is determined by the composite system "observer + object" [1, formula A.1].

Spaces and operators. The space of potential states $\mathcal{H}$ is infinite-dimensional (assumption D-Rich). The configuration space of actualized states $\mathbb{C}$ is finite-dimensional within the observer level with dimensionality $d(O)$. The observation operator $\hat{O}\colon \mathcal{H} \to \mathbb{C}$ performs actualization. The embedding operator $\iota\colon \mathbb{C} \to \mathcal{H}$ returns the actualized configuration to the space of potential states.

Self-observation mapping [1, formula U4.1]:

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

The fixed point $\Psi^* = \Phi(\Psi^*)$ defines a self-consistent configuration (Proposition 4 [1]).

Observer is specified by the vector [1, formula 4.2]:

$$O_i = (B_i,\, A_i,\, H_i) \in [0,\, 1] \times \mathcal{F} \times \mathcal{H}_{\text{hist}} \tag{II.2}$$

where B is contextual cognitive coherence, A is the focus of attention, and H is history.

Cognitive coherence [1, formula D1.1]:

$$B(O, C) = F^{w_1} \cdot E^{w_2} \cdot (1 - \sigma)^{w_3} \cdot \Lambda^{w_4} \tag{II.3}$$

where F is the focus of attention, E is coherence between independent observers, $(1 - \sigma)$ is self-consistency, and Λ is empirical corroboration.

Reconfiguration dynamics [1, formula 4.4]:

$$\frac{dC}{dt} = -\frac{\alpha}{I(C) + \varepsilon}\nabla U(C) + \eta(t) \tag{II.4}$$

where $I(C)$ is the inertia of the configuration, $U(C)$ is the potential, and $\eta(t)$ is a stochastic term with variance $D(\eta) = D_0 \cdot (1 - S)$.

System coherence [1, formula 4.5]:

$$S = 1 - \frac{2}{n(n-1)} \sum_{i<j} |B_i - B_j| \tag{II.5}$$

Ternary architecture [2, Section IV.2]. A minimal self-consistent act of observation requires three components: observer O, operator $\hat{O}$, and observed R. Cycle: $O \to \hat{O}(\Psi) = R \to \iota(R) = \Psi' \to O$.

Spiral dynamics [2, Section IV.1]. The transcendence of π is related to structural incompleteness: the self-observation loop does not close exactly ($S = 1$ is unattainable by Proposition 3 [1]), generating a spiral instead of a circle.

III. ORIGIN OF TIME FROM ITERATIVE DYNAMICS

3.1. Discrete Time: the Iteration Index

The ODTOE formalism contains an iterative sequence defined by the self-observation mapping:

$$\Psi_0 \to \Psi_1 = \Phi(\Psi_0) \to \Psi_2 = \Phi(\Psi_1) \to \ldots \to \Psi_n = \Phi(\Psi_{n-1}) \tag{III.1}$$

Each member of the sequence is the result of one complete revolution of the loop $O \to \hat{O} \to R \to \iota \to O$. Proposition 4 [1] guarantees (via the Banach contraction mapping theorem [17] or Schauder's theorem [18]) the existence of the limit $\Psi^* = \lim_{n\to\infty} \Psi_n$.

Thesis of the present work:

The index n of the iterative sequence $\{\Psi_n\}$ is the discrete precursor of time. (T-1)

Each act of observation—one application of the mapping Φ—generates one "tick" of time. Time does not precede observation: it is produced by observation.

Formally we define discrete time:

$$t_n = n \cdot \tau_0 \tag{III.2}$$

where τ_0 is the elementary duration of one revolution of the loop, determined by the inertia of the current configuration. The connection with the reconfiguration dynamics (II.4) is established through the estimate of the characteristic time:

$$\tau_0 \sim \frac{I(C)}{\alpha} \tag{III.3}$$

This estimate follows from equation (II.4) with $\eta = 0$ and a characteristic scale $|\nabla U| \sim U_0/L$: the configuration relaxation time is proportional to the inertia $I(C)$ and inversely proportional to the reconfiguration parameter α.

3.2. Spiral Time: Irreversibility

Proposition 3 [1] establishes that $S = 1$ is structurally unattainable as a consequence of self-reference (a strange loop in the sense of Hofstadter [30]): a complete description of reality would require including a description of the description itself (ad infinitum). Consequently, iterations do not lead to an exact return:

$$\delta\Psi_n = \Psi_{n+1} - \Psi_n \neq 0 \quad \text{for any finite } n \tag{III.4}$$

The transcendence of π guarantees this more rigorously. The article [2, Section IV.1] establishes that the phase advance of one complete revolution of the loop is 2π, and the incommensurability of π with the ternary architecture ($\pi \neq 3$, $\pi \neq p/q$ for any integers p, q) means that the spiral does not close after any finite number of revolutions.

This produces irreversibility: the sequence $\{\Psi_n\}$ is uniquely defined in the forward direction ($\Psi_{n+1} = \Phi(\Psi_n)$), but inversion (recovery of Ψ_n from Ψ_{n+1}) is not uniquely defined, since $\Phi = \iota \circ \hat{O}$, and the operator $\hat{O}\colon \mathcal{H} \to \mathbb{C}$ projects an infinite-dimensional space onto a finite-dimensional one. Projection is irreversible—information is lost.

The arrow of time is a consequence of the irreversibility of the projection $\mathcal{H} \to \mathbb{C}$. (T-2)

Formally: let $\dim \mathcal{H} = \infty$, $\dim \mathbb{C} = d < \infty$. Then the kernel of the operator $\hat{O}$ has infinite dimension:

$$\dim\ker(\hat{O}) = \infty \tag{III.5}$$

At each application of $\hat{O}$, the information contained in the kernel is lost. The embedding operator $\iota\colon \mathbb{C} \to \mathcal{H}$ recovers only a d-dimensional image. The infinity of $\dim\ker(\hat{O})$ is a quantitative measure of the irreversibility of a single act of observation.

3.3. Continuous Macroscopic Time

At high system coherence ($S \to 1$) the stochastic term in equation (II.4) is suppressed:

$$D(\eta) = D_0 \cdot (1 - S) \to 0 \quad \text{as } S \to 1 \tag{III.6}$$

In this regime the dynamics becomes quasi-deterministic:

$$\frac{dC}{dt} \approx -\frac{\alpha}{I(C)} \nabla U(C) \tag{III.7}$$

The continuous parameter t arises as the limit when $\tau_0 \to 0$, $n \to \infty$, $n \cdot \tau_0 = \text{const}$:

$$t = \lim_{\tau_0 \to 0} n \cdot \tau_0 \tag{III.8}$$

The smooth time coordinate appearing in classical physics is an approximation valid at $S \gg S_{\text{min}}$ and at scales significantly exceeding the elementary step τ_0. At the fundamental level, time is discrete and irreversible.

3.4. Three Levels of Temporality: Summary

Level	Definition	Metric	Reversibility
Discrete	n — iteration index of Φ	$\mathbb{N}$	Irreversible ($\dim\ker\hat{O} = \infty$)
Spiral	Accumulation of $\delta\Psi_n$	$\|\delta\Psi_n\| > 0\ \forall n$	Irreversible (transcendence of π)
Continuous	$t = \lim n\tau_0$	$\mathbb{R}_+$	Quasi-rev. ($S \to 1$)

IV. CHIRALITY OF THE SELF-OBSERVATION LOOP

4.1. Definition of Cycle Chirality

The self-observation loop $O \to \hat{O} \to R \to \iota \to O$ contains two structurally distinct operators: $\hat{O}\colon \mathcal{H} \to \mathbb{C}$ (actualization) and $\iota\colon \mathbb{C} \to \mathcal{H}$ (embedding). Their composition forms a closed cycle; however, $\hat{O}$ and ι do not commute and are not mutually inverse ($\dim\mathcal{H} \neq \dim\mathbb{C}$).

The chirality of the cycle is determined by the ordering of phases. The ODTOE cycle has a unique physically meaningful order:

$$\text{potential } (\mathcal{H}) \xrightarrow{\hat{O}} \text{actual } (\mathbb{C}) \xrightarrow{\iota} \text{potential } (\mathcal{H}') \tag{IV.1}$$

The reverse order ($\mathbb{C} \xrightarrow{\hat{O}^{-1}} \mathcal{H}$) is not an act of observation in the sense of Axiom (A): it would be a "deactualization" that does not generate an observer.

4.2. Spectral Argument: Sign of the Imaginary Part

Linearization of the mapping Φ in the neighborhood of the fixed point Ψ^* [2, Section III.2] yields an operator with complex eigenvalues:

$$\lambda = \alpha_0 \pm i\omega \tag{IV.2}$$

The condition for convergence of iterations to Ψ^* (Banach's theorem) requires $|\lambda| < 1$, which fixes $\alpha_0 < 0$ (decay). The imaginary part $+i\omega$ determines the direction of rotation of the phase vector—counterclockwise in the standard convention. This fixes the left-handedness of the spiral.

The choice of the sign $+i$ is dictated by Euler's identity [2, Section III.5]:

$$e^{i\pi} + 1 = 0 \tag{IV.3}$$

The exponential $e^{i\pi}$ performs a half-revolution in the positive direction (from $+1$ to -1 along the upper half-plane). A complete observation cycle corresponds to a phase advance of 2π with return $e^{i\cdot 2\pi} = 1$. The transcendence of π makes the closure inexact: the actual phase advance is $2\pi + \delta\varphi$, and this excess is positive (in the direction of the initial traversal).

4.3. Connection with P-Parity Violation

The Wu experiment (1957) established that the beta decay of polarized cobalt-60 violates spatial parity: electrons are emitted preferentially in the direction opposite to the nuclear spin [3]. This discovery, theoretically predicted by Lee and Yang [19], showed that the weak interaction distinguishes "left" from "right."

In the Standard Model, P-parity violation is postulated: only left-handed fermions participate in charged weak currents [20]. Why specifically left-handed is not explained.

In ODTOE, P-parity violation is derived from the unidirectionality of the actualization cycle. Beta decay in the subatomic interpretation of ODTOE [16, Section VII.2] is a transmutation of the observer (neutron) into the observed (proton) with generation of the operator (electron) and an informational residue (antineutrino). This process occurs in the forward direction of loop traversal (actualization), and the generated particles inherit the chirality of that direction.

The reverse process (β^+-decay: $p \to n + e^+ + \nu_e$) is a return of the observed to the state of the observer, occurring in the reverse direction of the cycle [16, Section VII.2]. The positron, as the reverse phase of the operator ($\iota\colon \mathbb{C} \to \mathcal{H}$), possesses the opposite chirality.

4.4. Why Specifically Left-Handed?

The act of observation—projection of $\mathcal{H}$ onto $\mathbb{C}$—is irreversible since $\dim \mathcal{H} \gg \dim \mathbb{C}$. The direction of projection (from greater dimensionality to lesser) defines the arrow of actualization. The spiral wound in the direction of this arrow is left-handed in the same sense in which the chirality of observed neutrinos is left-handed.

We formalize this through the asymmetry of the cycle phases. Define the durations of the forward and backward phases: $\tau_{\text{forward}} = \tau(\hat{O})$—the duration of actualization ($\mathcal{H} \to \mathbb{C}$); $\tau_{\text{backward}} = \tau(\iota)$—the duration of embedding ($\mathbb{C} \to \mathcal{H}$).

Projection onto a subspace of lesser dimensionality ($\hat{O}$) requires "more work" (information loss, selection from an infinite number of alternatives) than embedding into a space of greater dimensionality (ι). Consequently:

$$\tau_{\text{forward}} > \tau_{\text{backward}} \tag{IV.4}$$

This asymmetry of phase durations determines the predominance of the forward course over the backward one. At each complete revolution of the loop, the forward phase (actualization) occupies more "phase space" than the backward phase (embedding). Quantitatively, the asymmetry is related to the transcendental difference $\pi - 3 \approx 0.14159$, where 3 is the minimum number of components of the ternary architecture and π is the topological length of complete closure [2, Section IV.2].

4.5. Connection of Chirality with Baryon Asymmetry

The direct action of the operator $\hat{O}\colon \mathcal{H} \to \mathbb{C}$ (electron, charge -1) traverses at each revolution a slightly greater phase path than the reverse action $\iota\colon \mathbb{C} \to \mathcal{H}$ (positron, charge $+1$)—by the amount $\delta\varphi$ related to $(\pi - 3)$. This produces a systematic excess of the forward phase over the backward one, which in the subatomic interpretation [16] corresponds to the excess of matter over antimatter.

The quantitative connection between $(\pi - 3)$ and the observed baryon asymmetry parameter $\eta \approx 6 \times 10^{-10}$ [21] has not been established and remains an open problem. The many-orders-of-magnitude discrepancy ($\pi - 3 \approx 0.14$ versus $\eta \approx 6 \times 10^{-10}$) points to the need to account for suppression mechanisms (for example, multi-level recursion [16, Section IV]).

V. N. A. KOZYREV'S CAUSAL MECHANICS: MAIN PROVISIONS

To ensure a correct comparison, we present the central elements of causal mechanics in a form as close as possible to the original [4, 5].

5.1. Axiomatics

Kozyrev formulated three axioms on the properties of time [4, 5]:

Axiom I. In cause–effect relations, the cause and the effect are always separated by a spatial gap $\Delta x \neq 0$ and a temporal gap $\Delta t \neq 0$.

Axiom II. Causes always precede effects: $\Delta t > 0$.

Axiom III. Cause and effect are objectively distinguishable; the cause–effect relation possesses an absolute directionality independent of the reference frame.

To these, Shihobalov [12] added two implicit postulates:

Postulate IV. The course of time $c_2 = \Delta x/\Delta t$ is a fundamental constant.

Postulate V. Under rotation in a cause–effect link, additional forces arise that are not provided for by classical mechanics.

5.2. The Course of Time c_2

The quantity c_2 has the dimension of velocity and characterizes the speed of transition from cause to effect in an elementary cause–effect link. Kozyrev obtained the estimate on the basis of experiments with gyroscopes [5]:

$$c_2/\pi \approx 700 \text{ km/s} \tag{V.1}$$

whence $c_2 \approx 2200$ km/s. Kozyrev noted the connection with the fine-structure constant:

$$c_2 \approx \alpha \cdot c \approx \frac{1}{137} \cdot 3 \times 10^5 \text{ km/s} \approx 2190 \text{ km/s} \qquad \text{(V.2)}$$

The proximity of c_2 to the product of fundamental constants was regarded by Kozyrev as an argument in favor of the fundamentality of the course of time.

5.3. Asymmetric Forces

In the presence of rotation in a cause–effect link, an additional force arises [5, 12]:

$$\Delta F = \frac{u}{c_2} \cdot \cos(\mathbf{i}, \mathbf{j}) \cdot |F_0| \qquad \text{(V.3)}$$

where u is the linear rotational velocity, F_0 is the primary force (gravity), **i** is the direction of the course of time (from cause to effect), and **j** is the axis of rotation.

The effects measured by Kozyrev, as well as independently by Hayasaka and Takeuchi [14], were of the order of $(1–5) \times 10^{-5}$ of the gravitational force. The results remained controversial: the commissions of the Pulkovo Observatory [13] found them unconvincing, and attempts at reproduction yielded contradictory results (Faller et al. [22], Quinn and Picard [23], Nitschke and Wilmarth [31] did not find the effect; Lavrentiev et al. [24] confirmed it).

5.4. Connection of the Course of Time with Chirality

Kozyrev postulated that the course of time c_2 possesses a definite sign (pseudoscalar), linking the directionality of time with the distinction between right and left rotations [4, 5]. Experimentally this manifested in the dependence of the sign of the additional force on the direction of gyroscope rotation: right rotation (spin vector directed downward) caused a weight decrease; left rotation produced no effect [14].

Kozyrev explicitly cited the discovery of spatial parity violation in nuclear physics as confirmation of the asymmetry between mirror systems [5].

VI. COMPARISON OF ODTOE AND KOZYREV'S CAUSAL MECHANICS

6.1. Points of Structural Correspondence

Despite the difference of formalisms and eras of creation, nontrivial parallels are found between the two approaches.

(a) Time as an active rather than passive entity.

Kozyrev: time possesses its own physical properties; it does not merely parametrize evolution but actively participates in physical processes, serving as an energy source [4].

ODTOE: time is not a passive background but a product of the iterative dynamics of self-observation; it is generated by acts of reality constitution (thesis T-1, Section 3.1).

(b) Connection of time with causality.

Kozyrev: all three axioms contain the terms "cause" and "effect"; the course of time c_2 is defined through the speed of the cause–effect transition [4].

ODTOE: the iterative sequence $\Psi_{n+1} = \Phi(\Psi_n)$ is a chain of cause–effect acts, where the cause is the current configuration Ψ_n and the effect is the result of observation Ψ_{n+1}. The irreversibility of the chain (thesis T-2) formalizes the objective distinction between cause and effect.

(c) Connection of the course of time with rotation.

Kozyrev: additional forces manifest exclusively in rotating systems (Postulate V); the course of time has the dimension of velocity and is related to angular velocity [5].

ODTOE: the self-observation loop $O \to \hat{O} \to R \to \iota \to O$ is a cyclic (rotational) process. The phase advance of one revolution is 2π [2, Section III.1]. The spiral increment $\delta\Psi$ is generated precisely by the rotational nature of the loop.

(d) Chiral asymmetry.

Kozyrev: the course of time c_2 is a pseudoscalar distinguishing right from left; additional forces depend on the direction of rotation [5].

ODTOE: the self-observation loop possesses a fixed left-handed chirality (Section IV); P-parity violation is a consequence of the unidirectionality of actualization.

(e) Connection with the fine-structure constant.

Kozyrev: $c_2 \approx \alpha \cdot c \approx (1/137) \cdot c$ [5, 12].

ODTOE: the fine-structure constant $\alpha = e^2/(4\pi\varepsilon_0\hbar c)$ contains $\hbar = h/(2\pi)$, and the factor 2π is interpreted in ODTOE as the topological length of one complete self-observation cycle [2, Section V]. The connection of α with the ODTOE formalism remains at the level of structural correspondence and requires further development.

6.2. Principal Divergences

(a) Ontological status of time.

Kozyrev: time is substantival—it is a "grand flow encompassing all material processes" [25]; the substantival interpretation was developed by Levich [32]. Time exists independently of the observer as a physical substance.

ODTOE: time is emergent—it is produced by acts of observation and does not exist outside the iterative dynamics. No observer—no iterations—no time.

(b) Role of the observer.

Kozyrev: the observer does not appear in the axiomatics; causal mechanics is an objectivist theory supplementing Newtonian mechanics [4].

ODTOE: the observer is the primary agent of reality formation (Axiom A [1]); its parameters (B, A, H) enter into all the main formulae.

(c) Mechanism of irreversibility.

Kozyrev: irreversibility is postulated (Axiom II: $\Delta t > 0$) [4].

ODTOE: irreversibility is derived from the structure of the projection $\mathcal{H} \to \mathbb{C}$ ($\dim\ker(\hat{O}) = \infty$, formula III.5).

(d) Discreteness vs. continuity.

Kozyrev: the course of time c_2 is a continuous quantity; discretization is not provided for [4].

ODTOE: at the fundamental level, time is discrete (iteration index n); continuity is an approximation at $S \gg S_{\text{min}}$ (Section 3.3).

(e) Experimental basis.

Kozyrev: laboratory experiments with gyroscopes, pendulums, torsion balances; astronomical observations [4, 5, 24]. Results are controversial; reproducibility has not been unambiguously confirmed [13, 22, 23].

ODTOE: the experimental basis relies on established results of particle physics (P-parity violation [3], neutrino oscillations [26, 27], baryon asymmetry [21]) and cosmology [28]. The theory has not yet produced direct experimental predictions of its own.

6.3. Comparison Summary Table

Parameter	**Kozyrev's Causal Mechanics**	**ODTOE**
Ontology of time	Substantival	Emergent (product of iterations)
Role of observer	Absent	Central (Axiom A)
Source of irreversibility	Postulate ($\Delta t > 0$)	Derivation ($\dim\ker\hat{O} = \infty$)
Connection with rotation	Postulate V (gyroscope)	Cyclic nature of loop (2π)
Chiral asymmetry	Pseudoscalarity of c_2	Left-handed spiral ($\hat{O} \neq \iota^{-1}$)
Fundamental constant	$c_2 \approx \alpha \cdot c$	$\tau_0 \sim I(C)/\alpha$
Arrow of time	Causality (Axiom II)	Irreversibility of $\mathcal{H} \to \mathbb{C}$
Entropy	Time counteracts growth	Non-closure ensures inexhaustibility
Discreteness	Continuous flow	Discrete iterations
Exp. status	Controversial	Indirect (P-violation, ν-oscillations)

6.4. Reinterpretation of Kozyrev's Effects Through ODTOE

Let us assume that the effects discovered by Kozyrev (and partially reproduced by Hayasaka–Takeuchi and Lavrentiev) are real. Then, within the ODTOE framework, the following reinterpretation can be proposed.

A gyroscope—a macroscopic system with a distinguished direction of rotation—creates a coherent configuration with a high parameter S. When rotating in a specific direction (coinciding with the chirality of the self-observation loop), the coherence of the system locally increases, which by formula (P3.1) [1]:

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

increases the lifetime of the configuration. An increase in configuration stability may manifest as a decrease in effective weight (the configuration "resists" gravitational reconfiguration). When rotating in the opposite direction, the effect is absent because the reverse chirality does not match the chirality of the loop.

This interpretation is hypothetical in nature and has not been deductively derived from the ODTOE axiomatics. It is proposed as a program for further research, not as an established result.

VII. DUALITY OF THE NEUTRINO AND TIME

The article [29] establishes the identification of the neutrino with the spiral residue of the self-observation loop: $\nu \sim \delta\Psi = \Psi_{n+1} - \Psi_n$. Comparison with the results of the present work reveals a duality:

$$\nu \sim \frac{d\Psi}{d\varphi}, \qquad t \sim \int \frac{d\varphi}{\omega} \tag{VII.1}$$

$\delta\Psi$ is the "what" (the informational residue of a revolution), while $\delta t = \tau$ is the "how much" (the parametric count of the same revolution). Each act of observation simultaneously generates a quantum of time and a quantum of neutrino.

This duality is consistent with experimental data. The cosmic abundance of relic neutrinos (~ 336 cm^{-3} [28]) indicates that acts of reality constitution occur ubiquitously and continuously—just as time "ticks" ubiquitously and continuously. The coincidence in order of the number of photons (~ 410 cm^{-3}) and neutrinos (~ 336 cm^{-3}) in the relic background points to a common origin of both from fundamental processes in the early Universe.

VIII. LIMITATIONS

The proposed construction has a number of significant limitations that must be noted.

First, the derivation of time from iterative dynamics (Section III) depends on the existence of the fixed point Ψ^* and the convergence of the sequence $\{\Psi_n\}$, which requires specification of the analytic properties of the operators $\hat{O}$ and ι—a task identified in [1, Section II] as open.

Second, the thesis of left-handedness (Section IV) rests on the spectral argument, which assumes the assumptions D-Top and D-Fr [2, Section VI.2], whose rigorous justification remains incomplete.

Third, the quantitative correspondence between $(\pi - 3)$ and the baryon asymmetry $\eta \approx 6 \times 10^{-10}$ has not been established. The many-orders-of-magnitude discrepancy requires explanation.

Fourth, the reinterpretation of Kozyrev's effects (Section 6.4) is hypothetical in nature and does not generate quantitative predictions. Without such predictions it remains a heuristic.

Fifth, the comparison of the two theories (Section VI) is structural rather than formal: there is no unified mathematical formalism into which both approaches could be embedded as special cases.

Sixth, the elementary duration τ_0 (formula III.3) has no numerical estimate within the current ODTOE formalism, since the parameters α and $I(C)$ are not quantitatively specified.

IX. CONCLUSION

The following results have been established.

(1) Time in ODTOE arises as a by-product of the iterative dynamics of the self-observation mapping Φ. The discrete precursor of time is the iteration index n. Spiral time is a consequence of the non-closure of the loop ($\delta\Psi_n \neq 0$ for all n). Continuous macroscopic time is an approximation at high coherence.

(2) The arrow of time is derived (not postulated) from the irreversibility of the projection $\mathcal{H} \to \mathbb{C}$: the infinite-dimensional kernel of the operator $\hat{O}$ ensures the irrecoverability of the previous state from the subsequent one.

(3) The chirality of the self-observation loop is left-handed. This is fixed by the ordering of operators ($\hat{O}$ precedes ι), the asymmetry of dimensionalities ($\dim \mathcal{H} > \dim \mathbb{C}$), and the positive sign of the imaginary part of the eigenvalues of the linearized operator Φ. Left-handedness is consistent with the experimentally established P-parity violation in weak interactions.

(4) Between ODTOE and Kozyrev's causal mechanics, five structural correspondences are found: the active role of time, the connection with causality, the attachment to rotation, the chiral asymmetry, and the connection with the fine-structure constant. At the same time, the two approaches diverge on a key point: Kozyrev postulates the substantiality of time, whereas ODTOE derives its emergence.

(5) Time and the neutrino are dual: the neutrino is $d\Psi/d\varphi$ (the derivative of the configuration with respect to phase); time is $\int d\varphi/\omega$ (the integral over phase). Each

act of observation generates a quantum of both.

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