

THE ATOM AS AN ELEMENTARY STRANGE LOOP IN THE OBSERVER-DEPENDENT THEORY OF EVERYTHING (ODTOE)

The subatomic triple, recursive self-similarity,
the unified observation operator, and the neutrino as a helical gap

(Атом как элементарная странная петля
в наблюдатель-зависимой теории всего)

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ABSTRACT

Within the framework of the Observer-Dependent Theory of Everything (ODTOE) [1], an interpretation of subatomic particles as components of the triadic architecture of the minimal self-consistent act of observation is proposed: the proton is identified with the observable $R \in \mathcal{C}$, the neutron with the observer $O = (B, A, H)$, and the electron with the observation operator $\hat{O} : \mathcal{H} \rightarrow \mathcal{C}$. It is shown that this identification is consistent with the ODTOE formalism across nine independent parameters: the stability of the proton is derived from the stability of the fixed point $\Psi^* = \Phi(\Psi^*)$; the instability of the free neutron from the impossibility of self-consistent existence of an isolated observer; the delocalization of the electron from the functional nature of the operator. The principle of recursive self-similarity (∞ -nesting) is introduced, according to which each proton contains an internal triadic architecture at a substructural level, and this architecture is reproduced at all scales. A connection with the Wheeler–Feynman one-electron hypothesis [3, 4] is established: the electron is reinterpreted as a unified operator \hat{O} , whose direct action ($\hat{O} : \mathcal{H} \rightarrow \mathcal{C}$) manifests as an electron, the inverse action ($\iota : \mathcal{C} \hookrightarrow \mathcal{H}$) as a positron, and the baryon asymmetry is explained by the helical dynamics of the self-observation loop (transcendence of π [2]). A hypothesis of cross-scale quantum entanglement of the unified operator between levels of ∞ -recursion is formulated. The neutrino is interpreted as a helical gap $\delta\Psi$ – a materialization of the fundamental incompleteness of the strange loop closure; neutrino oscillations are described as rotation of the vector $\delta\Psi$ in the space of junctions of the triadic architecture.

Keywords: atom, observer, ODTOE, strange loop, fixed point, triadic architecture, recursive self-similarity, single electron, baryon asymmetry, cross-scale entanglement, neutrino, helical gap, oscillations.

АННОТАЦИЯ

В рамках наблюдатель-зависимой теории всего (ODTOE) [1] предложена интерпретация субатомных частиц как компонентов тройственной архитектуры минимального самосогласованного акта наблюдения: протон отождествляется с наблюдаемым $R \in \mathcal{C}$, нейтрон — с наблюдателем $O = (B, A, H)$, электрон — с оператором наблюдения $\hat{O} : \mathcal{H} \rightarrow \mathcal{C}$. Показано, что данное отождествление согласуется с формализмом ODTOE по девяти независимым параметрам: стабильность протона выводится из устойчивости неподвижной точки $\Psi^* = \Phi(\Psi^*)$; нестабильность свободного нейтрона — из невозможности самосогласованного существования изолированного наблюдателя; делокализованность электрона — из функциональной природы оператора. Введён принцип рекурсивного самоподобия (∞ -вложения), согласно которому каждый протон содержит внутреннюю тройственную архитектуру на субструктурном уровне, и эта архитектура воспроизводится на всех масштабах. Установлена связь с гипотезой единого электрона Уилера–Фейнмана [3, 4]: электрон переосмысливается как единый оператор \hat{O} , прямое действие которого ($\hat{O} : \mathcal{H} \rightarrow \mathcal{C}$) проявляется как электрон, обратное ($\iota : \mathcal{C} \hookrightarrow \mathcal{H}$) — как позитрон, а барионная асимметрия объясняется спиральностью динамики петли самонаблюдения (трансцендентность π [2]). Сформулирована гипотеза межмасштабной квантовой запутанности единого оператора между уровнями ∞ -рекурсии. Нейтрино интерпретируется как спиральный зазор $\delta\Psi$ — материализация принципиальной неполноты замыкания странной петли; нейтринные осцилляции описываются как вращение вектора $\delta\Psi$ в пространстве стыков тройственной архитектуры.

Ключевые слова: атом, наблюдатель, ODTOE, странная петля, неподвижная точка, тройственная архитектура, рекурсивное самоподобие, единый электрон, барионная асимметрия, межмасштабная запутанность, нейтрино, спиральный зазор, осцилляции.

I. INTRODUCTION

1.1. Problem statement

The triadic architecture of the minimal self-consistent act of observation — observer, observable, observation operator — constitutes the central structural element of ODTOE [1, 2]. In the article on π as a structural invariant [2], it was established that the exclusion of any one of the three components renders the closure of the self-observation loop impossible, and the number “three” is related to the lower bound of Archimedes $\pi > 3$.

The subatomic structure of matter exhibits a fundamental triplicity: the atom is composed of a proton, a neutron, and an electron — three particles with radically

different properties:

	Charge	Mass (MeV/ c^2)	Lifetime
Proton p^+	+1	938.3	$> 2.4 \times 10^{34}$ yr
Neutron n^0	0	939.6	≈ 878 s (free)
Electron e^-	-1	0.511	$> 6.6 \times 10^{28}$ yr

The present work investigates the extent to which the identification of the subatomic triple with the components of the triadic architecture of ODTOE is internally consistent and generates substantive consequences.

1.2. Structure of the paper

Section II reproduces the necessary elements of the ODTOE formalism. Section III formulates the identification and verifies its consistency. Section IV introduces the principle of recursive self-similarity. Section V establishes the connection with the Wheeler–Feynman one-electron hypothesis. Section VI formulates the hypothesis of cross-scale entanglement. Section VII introduces the interpretation of the neutrino as a helical gap. Section VIII discusses heavy elements and decay types. Section IX contains a summary table of correspondences. Section X discusses consequences and limitations. Section XI presents the conclusions.

II. NECESSARY ELEMENTS OF THE ODTOE FORMALISM

For self-containedness of the exposition, we reproduce the key definitions [1, 2].

Axiom (A). The observer and the observable are mutually constituted in the act of observation:

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

where R is the observed configuration, \hat{O} is the observation operator, $\Psi \in \mathcal{H}$ is the field of potential states [1, formula A.1].

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

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

Contextual cognitive coherence [1, formula D1.1]:

$$B(O, C) = F^{w_1} \cdot E^{w_2} \cdot (1 - \sigma)^{w_3} \cdot \Lambda^{w_4} \quad (\text{II.2})$$

where F is the focus of attention, E is the emotional coherence, σ is the internal contradiction, Λ is the empirical reinforcement.

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

$$\Phi(\Psi) = \iota(\hat{O}_\Psi(\Psi)) \quad (\text{II.3})$$

where $\iota : \mathcal{C} \hookrightarrow \mathcal{H}$ is the embedding operator. The **fixed point** $\Psi^* = \Phi(\Psi^*)$ defines the self-consistent configuration (Proposition 4 [1]).

Triadic architecture [2, section IV.2]: the minimal act of observation requires three components: (1) observer O ; (2) observable $R \in \mathcal{C}$; (3) operator $\hat{O} : \mathcal{H} \rightarrow \mathcal{C}$. This triplicity is related to the estimate $\pi > 3$, and the exact value $\pi \approx 3.14159$ expresses the nonlinear “curvature” of the act of observation, exceeding the minimal triplicity [2, section IV.2].

Assumption D-Prot [1, section 4.2]: the dimensionality parameter $d(O) \in \mathbb{N}$ specifies the hierarchy of observation levels. The current version of ODTOE sets $d(O) = \infty$.

III. IDENTIFICATION OF THE SUBATOMIC TRIPLE

3.1. Hypothesis formulation

The following correspondence is proposed:

$$\underbrace{p^+}_{R \in \mathcal{C}} \longleftarrow \underbrace{e^-}_{\hat{O} : \mathcal{H} \rightarrow \mathcal{C}} \longleftarrow \underbrace{n^0}_{O = (B, A, H)} \quad (\text{III.1})$$

Particle	Role in ODTOE	Charge	Formal analogue
Proton (p^+)	Observable R	+1	Actualized configuration in \mathcal{C}
Neutron (n^0)	Observer O	0	Agent applying \hat{O} to Ψ
Electron (e^-)	Operator \hat{O}	-1	Mapping $\mathcal{H} \rightarrow \mathcal{C}$

An essential clarification: the neutron is identified with the observer O , defined by the vector (B, A, H) , and not with the field of potential states Ψ . The observer and the field are distinct entities in the ODTOE formalism: O is the agent applying the operator to Ψ , not an element of Ψ . The anti-world, in this interpretation, is the domain where the observer resides as a potential agent of constitution prior to the act of observation.

3.2. Consistency verification

The verification is carried out across nine independent parameters.

(i) Proton stability. The lower bound on the proton lifetime: $\tau_p > 2.4 \times 10^{34}$ years [5]. Stability is ensured not by the formula $T(C) = T_0/(1 - S)^n$ directly, but by the fact that the proton is a component of $\Psi^* = \Phi(\Psi^*)$. Stability is guaranteed by the properties of Φ : contractivity (Banach’s theorem [6]) or compactness of the image (Schauder’s theorem [7]).

(ii) Instability of the free neutron. Outside the nucleus: $n \rightarrow p + e^- + \bar{\nu}_e$, $\tau_n \approx 878$ s [5]. An observer not included in a closed loop Ψ^* lacks self-consistency. Decay is the forced actualization of an isolated observer.

(iii) Neutron stability within the nucleus. An observer integrated into a closed self-observation loop Ψ^* acquires stability.

(iv) Electrical neutrality of the atom. $(+1) + (0) + (-1) = 0$ — an expression of the closure of the strange loop: actualization $(+1)$ is completely compensated by the bond (-1) .

(v) Delocalization of the electron. The operator \hat{O} is a functional $\mathcal{H} \rightarrow \mathcal{C}$, not an element of \mathcal{C} . Its “presence” is defined by its domain of action on Ψ , not by a coordinate.

(vi) Mass ratio. The neutron mass exceeds the proton mass by $1.293 \text{ MeV}/c^2$ — an asymmetry reflecting the content of the vector $O = (B, A, H)$, which does not fully reduce to the configuration R .

(vii) Quark structure. The proton (uud) and the neutron (udd) each contain three valence quarks, reproducing the triadic architecture at the substructural level (Section IV).

(viii) Discrete spectrum. The quantization of orbits corresponds to the spectral argument [2]: the imaginary part of the eigenvalues of the linearized operator Φ determines the period $T = 2\pi/\omega$.

(ix) Antineutrino as a marker of structural incompleteness. In β -decay, three “architectural” products arise and one “excess” product — $\bar{\nu}_e$. A self-referential strange loop [15, 16] contains an irreducible structural incompleteness ($S = 1$ is unattainable). A detailed interpretation of the neutrino is given in Section VII.

3.3. Remark on epistemic status

The proposed identification is heuristic in nature — a formal deductive connection between the axiomatics of ODTOE and specific subatomic particles has not been established.

IV. THE PRINCIPLE OF RECURSIVE SELF-SIMILARITY

4.1. Formulation

Each observable R at level d contains an internal self-consistent configuration Ψ_{d-1}^* and is itself a component of Ψ_{d+1}^* :

$$\dots \subset \Psi_{d-2}^* \subset \Psi_{d-1}^* \subset \Psi_d^* \subset \Psi_{d+1}^* \subset \Psi_{d+2}^* \subset \dots \quad (\text{IV.1})$$

4.2. Justification

The principle follows from three elements of the formalism:

From Proposition 3 (strange loop [1]): $T_{\text{ODTOE}} \in \mathcal{T}$ and $T_{\text{ODTOE}} \vdash |\mathcal{T}|$. Similarly: the proton as observable R belongs to the configuration Ψ^* , whose structure it (as a component of the loop) determines.

From Proposition 4 (bootstrap [1]): $\Phi(\Psi) = \iota(\hat{O}_\Psi(\Psi))$ — a recursive chain contracted into a fixed point.

From Assumption D-Prot [1, section 4.2]: $d(O) \in \mathbb{N}$; in the original formulation $d(O)$ is not bounded from above.

4.3. Physical realization

At each level, the triadic architecture is reproduced:

$$\begin{aligned}
 d = 0 \text{ (atom)} : & \quad p(R_0) \quad \longleftarrow \quad e^-(\hat{O}_0) \quad \longleftarrow \quad n(O_0) \\
 d = -1 \text{ (nucleon)} : & \quad u(R_{-1}) \quad \longleftarrow \quad g(\hat{O}_{-1}) \quad \longleftarrow \quad d(O_{-1}) \\
 d = +1 \text{ (molecule)} : & \quad \text{atom}(R_{+1}) \quad \longleftarrow \quad \text{bond}(\hat{O}_{+1}) \quad \longleftarrow \quad \text{atom}(O_{+1})
 \end{aligned} \tag{IV.2}$$

4.4. Resolution of the hydrogen paradox

Hydrogen-1 (${}^1\text{H} = 1p + 1e$, without a neutron) is a “loop without an external observer.” The proton contains an internal triple (three quarks bound by gluons), ensuring self-consistency at level $d = -1$.

Deuterium (${}^2\text{H} = p + n + e$) realizes the full loop simultaneously at two levels: via the neutron ($d = 0$) and via the quark triples ($d = -1$).

4.5. Connection with Leibniz’s monadology

Recursive self-similarity reproduces the Leibnizian principle: each monad contains a “folded universe” (Monadologie, § 63 [8]). The idea of emergent structure from self-referential mechanisms finds a parallel in pregeometric models [17]. The fixed point Ψ^* is interpreted as the “monad of monads” [1, section 6.12] — a configuration containing the ground of its own existence. Demarcation: in Leibniz, harmony is pre-established externally; in ODTOE, coherence arises dynamically through collective observation (postulate P5 [1]).

V. THE UNIFIED OBSERVATION OPERATOR: REINTERPRETATION OF THE WHEELER–FEYNMAN HYPOTHESIS

5.1. The one-electron hypothesis

J. A. Wheeler proposed to R. Feynman the idea that all electrons and positrons are manifestations of a single entity moving forward and backward in time [3]. Feynman formalized the interpretation of the positron as an electron moving backward in time [4]; Nambu [9] generalized the principle to all particle–antiparticle pairs. Independently, an analogous description was developed by Stueckelberg [10].

The hypothesis did not develop into a physical theory for two reasons: (a) baryon asymmetry — there are substantially more electrons than positrons; (b) modern QFT treats the electron as an excitation of a quantum field rather than an identifiable particle.

5.2. Reformulation in the language of ODTOE

The ODTOE formalism contains two directions of action that directly map Wheeler’s idea:

Direct action: $\hat{O} : \mathcal{H} \rightarrow \mathcal{C}$ — the transition from the field of potential states to a configuration (actualization). This is “forward motion in time” in Wheeler’s terminology. Manifestation: electron (charge -1).

Inverse action: $\iota : \mathcal{C} \hookrightarrow \mathcal{H}$ — the embedding of a configuration back into the field [1, formula U4.1]. This is “backward motion in time.” Manifestation: positron (charge $+1$).

The self-observation mapping unifies both actions:

$$\Phi = \iota \circ \hat{O} \tag{V.1}$$

The electron and the positron are two phases of a unified operator completing the full cycle of the strange loop.

Within the ∞ -recursion, the unified operator \hat{O} passes through all levels:

$$\hat{O} = \bigoplus_{d \in \mathbb{Z}} \hat{O}_d \tag{V.2}$$

5.3. Resolution of baryon asymmetry

The loop dynamics is helical (π is transcendental [2]):

$$\Psi \xrightarrow{\hat{O}} R \xrightarrow{\iota} \Psi', \quad \Psi' \neq \Psi \tag{V.3}$$

The increment $\pi - 3 \approx 0.14159$ per revolution creates a systematic asymmetry between the \hat{O} phase (electron) and the ι phase (positron).

The quantitative relationship between $(\pi - 3)$ and the magnitude of the baryon asymmetry $\eta \approx 6 \times 10^{-10}$ [5] has not been established and constitutes an open problem.

5.4. “Positrons are hidden in protons”

Wheeler’s remark [3] acquires a literal meaning: each proton contains an internal loop $\Phi_d = \iota_d \circ \hat{O}_d$ at each substructural level $d < 0$. The inverse action ι_d (positron phase) is embedded in the structure of the proton and is inaccessible to the observer at $d(O) > d$ (Assumption D-Prot [1]).

VI. CROSS-SCALE QUANTUM ENTANGLEMENT OF THE UNIFIED OPERATOR

6.1. Statement

The projections $\hat{O}_{d_1}, \hat{O}_{d_2}$ of the unified operator onto different levels are not independent. The fixed point Ψ^* links all levels through a single mapping Φ , and the state $|\Psi^*\rangle$ is not separable across levels.

6.2. Formal construction

Decomposition of the fixed point by nesting levels:

$$\Psi^* \in \mathcal{H} = \bigotimes_{d \in \mathbb{Z}} \mathcal{H}_d \quad (\text{VI.1})$$

The state $|\Psi^*\rangle$ is not separable. Nonzero von Neumann entropy of the reduced density matrix:

$$S(\rho_d) = -\text{Tr}(\rho_d \ln \rho_d) > 0, \quad \text{where } \rho_d = \text{Tr}_{\neq d} |\Psi^*\rangle \langle \Psi^*| \quad (\text{VI.2})$$

indicates the entanglement of level d with the remaining levels of recursion.

6.3. Fractal structure of entanglement

Works [11, 12, 13] establish self-similar patterns of entanglement on fractal structures. The golden ratio $\varphi = (1 + \sqrt{5})/2$, being a complementary invariant of ODTOE [2, section V-bis], potentially determines the scaling:

$$S(\rho_d) \propto \varphi^{-|d-d_0|} \quad (\text{VI.3})$$

where d_0 is the observer's level. This is consistent with D-Prot: entanglement is maximal at the observer's level and decays toward inaccessible levels with a characteristic scale of φ .

VII. THE NEUTRINO AS A HELICAL GAP $\delta\Psi$

7.1. Origin of the gap

Each revolution of the self-observation loop maps Ψ to $\Psi' = \Phi(\Psi)$. Proposition 3 [1] establishes: $S = 1$ is structurally unattainable. Therefore:

$$\delta\Psi \equiv \Psi' - \Psi = \Phi(\Psi) - \Psi \neq 0 \quad (\text{VII.1})$$

The increment $\delta\Psi$ is the information generated by the act of observation that cannot be accommodated in R , O , or \hat{O} .

Hypothesis. The neutrino is the materialization of $\delta\Psi$ — the residue of the non-closure of the strange loop.

7.2. Properties of the neutrino from the properties of $\delta\Psi$

Mass. The loop *almost* closes, therefore $|\delta\Psi|$ is infinitesimally small. The dispersion of fluctuations $D(\eta) = D_0 \cdot (1 - S)$ [1] relates the gap to coherence:

$$|\delta\Psi| \propto (1 - S) \quad \implies \quad m_\nu \propto (1 - S) \quad (\text{VII.2})$$

Experimentally: $\sum m_\nu < 0.12$ eV (cosmological bound on the sum of masses of three generations; Planck 2018 + BAO [5]) — six orders of magnitude lighter than the electron.

Zero charge. $\delta\Psi$ does not belong to either the \hat{O} phase (charge -1), or R ($+1$), or O (0 as an agent). The residue of the helix is orthogonal to the triadic architecture.

Weak interaction. $\delta\Psi$ is “perpendicular” to the loop components — it is generated by the loop but does not participate in its functioning. Analogy: Gödel's theorem generates a true statement that is unprovable *within* the system.

Ubiquity. Each revolution of every strange loop at every level of ∞ -recursion produces its own $\delta\Psi$. Hence — $\sim 10^{89}$ neutrinos in the visible Universe.

Left-handedness. The helix of self-observation has a definite chirality (direction of traversal $O \rightarrow \hat{O} \rightarrow R \rightarrow \iota \rightarrow O$), and $\delta\Psi$ inherits this chirality.

7.3. Three generations

The triadic architecture has three junctions. Let us denote the corresponding subspaces \mathcal{H}_O , $\mathcal{H}_{\hat{O}}$, \mathcal{H}_R . The vector $\delta\Psi$ projects as:

$$\delta\Psi = \alpha \mathbf{e}_O + \beta \mathbf{e}_{\hat{O}} + \gamma \mathbf{e}_R \quad (\text{VII.3})$$

where $\mathbf{e}_O, \mathbf{e}_{\hat{O}}, \mathbf{e}_R$ are unit directions along the junctions, and the coefficients determine the detection probabilities of the generations:

$$|\alpha|^2 \sim P(\nu_e), \quad |\beta|^2 \sim P(\nu_\mu), \quad |\gamma|^2 \sim P(\nu_\tau) \quad (\text{VII.4})$$

Generation	Loop junction	Physical process
ν_e	$O \rightarrow \hat{O}$ (observer \rightarrow operator)	Generation of the act of observation
ν_μ	$\hat{O} \rightarrow R$ (operator \rightarrow observable)	Actualization of configuration
ν_τ	$R \xrightarrow{\iota} O$ (observable \rightarrow observer)	Loop closure

7.4. Neutrino oscillations

The loop continues its helical motion — the phase of $\delta\Psi$ shifts relative to the segments. The vector $\delta\Psi$ *rotates* in the junction space with a frequency determined by the spectrum of Φ .

Spectral argument [2]: the eigenvalues of the linearized operator Φ contain an imaginary part ω . Different eigenvalues yield different frequencies — interference produces the oscillation pattern.

Mixing angles. In standard physics, oscillations are described by the PMNS matrix with angles $\theta_{12}, \theta_{23}, \theta_{13}$. In the language of ODTOE, these angles are determined by the *geometry of the loop* — the degree of deviation of the junctions from equal division $2\pi/3$:

$$\theta_{ij} = f_{ij}(\Delta\varphi_O, \Delta\varphi_{\hat{O}}, \Delta\varphi_R) \quad (\text{VII.5})$$

where f_{ij} are unknown functions and $\Delta\varphi_X$ is the arc length of segment X ($\Delta\varphi_O + \Delta\varphi_{\hat{O}} + \Delta\varphi_R = 2\pi$). Experimentally: $\theta_{12} \approx 33^\circ, \theta_{23} \approx 45^\circ, \theta_{13} \approx 8.5^\circ$ — the inequality of the angles reflects the fundamental non-equivalence of the three components of the triadic architecture.

CP phase. CP violation determines the difference in oscillations between neutrinos and antineutrinos. In ODTOE: the direct \hat{O} and inverse ι are not symmetric (helicity). The gap in the forward and reverse traversals rotates at different speeds — CP violation in the neutrino sector is a direct manifestation of the loop helicity ($\pi \neq 3$), the same one that explains baryon asymmetry.

7.5. Mass differences between generations

Experimentally:

$$\frac{\Delta m_{32}^2}{\Delta m_{21}^2} = \frac{2.5 \times 10^{-3} \text{ eV}^2}{7.5 \times 10^{-5} \text{ eV}^2} \approx 33 \quad (\text{VII.6})$$

The three junctions have different “arc lengths.” The gap projected onto a longer segment receives a greater effective “weight.” The mass difference reflects the degree of asymmetry between the roles of the observer, the operator, and the observable.

7.6. Variability of the gap

The magnitude $|\delta\Psi|$ depends on the coherence S :

$$|\delta\Psi| \propto (1-S) \quad \xrightarrow{S \rightarrow 1} \quad |\delta\Psi| \rightarrow 0 \quad (\text{but } \neq 0, \text{ since } S = 1 \text{ is unattainable}) \quad (\text{VII.7})$$

The gap is irreducible — the neutrino *always* exists as long as at least one self-observation loop exists. It is the most indestructible “particle” in the Universe — not because it is stable (as the proton through Ψ^*), but because it embodies the fundamental incompleteness theorem.

7.7. Neutrino vs antineutrino

By analogy with electron/positron:

$\bar{\nu}$: $\delta\Psi$ in the direction of \hat{O} (“forward,” β^- -decay).

ν : $\delta\Psi$ in the direction of ι (“backward,” β^+ -decay, electron capture).

7.8. ∞ -recursion of the neutrino

At each level of the ∞ -recursion of the proton, there exist neutrinos of their own — gaps of the quark loop ($d = -1$), the atomic loop ($d = 0$), the molecular loop ($d = +1$), etc. Only neutrinos of one’s own level are observable (D-Prot). The totality of gaps across all levels explains the colossal abundance of neutrinos in the Universe.

VIII. HEAVY ELEMENTS AND DECAY TYPES

8.1. Multi-observer nuclei

An atom with Z protons, N neutrons, and Z electrons forms a system of Z observables, N observers, and Z operators. For heavy stable nuclei ($Z > 20$), it is characteristic that $N > Z$ — the principle of coherent stabilization.

8.2. Decay types as role transmutations

β^- -decay ($n \rightarrow p + e^- + \bar{\nu}_e$): the observer transmutes into the observable — potentiality (Anti-world) transitions into actuality (World) with the generation of an operator and an informational residue (gap).

β^+ -decay ($p \rightarrow n + e^+ + \nu_e$): the observable returns to the observer state. The embedding operator $\iota : \mathcal{C} \hookrightarrow \mathcal{H}$ [1, formula U4.1] in its pure form; the positron is the inverse phase of the unified operator.

α -decay (emission of ${}^4\text{He}$): the collective ejection of two observers and two observables with their operators — the loss of a closed fragment of the loop.

8.3. Magic numbers

Nuclei with magic numbers of nucleons (2, 8, 20, 28, 50, 82, 126) [14] possess anomalous stability — these are values of Z and N at which the coherence of the system of observers and observables reaches local maxima.

IX. SUMMARY TABLE OF CORRESPONDENCES

ODTOE concept	Formula	Subatomic analogue	Wheeler–Feynman
Observer $O = (B, A, H)$	(II.1)	Neutron	—
Observable $R \in \mathcal{C}$	(A.1)	Proton	—
Unified operator \hat{O}	(V.2)	Electron	One electron
Direct $\hat{O} : \mathcal{H} \rightarrow \mathcal{C}$	(A.1)	e^- (-1)	Forward in time
Inverse $\iota : \mathcal{C} \hookrightarrow \mathcal{H}$	(II.3)	e^+ (+1)	Backward in time
Cycle $\Phi = \iota \circ \hat{O}$	(V.1)	e^-/e^+ annihilation	World-line zigzag
Helical gap $\delta\Psi$	(VII.1)	Neutrino	—
Projections of $\delta\Psi$	(VII.4)	ν_e, ν_μ, ν_τ	—
Rotation of $\delta\Psi$	section 7.4	Oscillations	—
Helicity ($\pi \neq 3$)	(V.3)	Baryon asymmetry	Deficit of positrons
∞ -recursion	(IV.1)	Quark \rightarrow nucleon \rightarrow atom	Positrons in protons
Cross-scale entanglement	(VI.2)	Atom/nucleus correlations	Identity of electrons
Structural incompleteness	Prop. 3	$\bar{\nu}_e$	—

X. DISCUSSION

10.1. Testable consequences

The interpretation explains: the triplicity of the subatomic architecture; the instability of the free neutron; the stability of the proton (including hydrogen without a neutron); the neutrality of the atom; the delocalization of the electron; $N \geq Z$ for heavy nuclei; β -decay as role transmutation; baryon asymmetry (qualitatively); the identity of electrons; the smallness of the neutrino mass; three neutrino generations; neutrino oscillations; CP violation in the neutrino sector.

10.2. Limitations

(a) The identification is heuristic in nature — a formal deductive connection with the axiomatics of ODTOE has not been established.

(b) The scaling operator Σ_d (Section IV) is not rigorously specified — its definition constitutes an open problem.

(c) The quantitative relationship $(\pi - 3) \leftrightarrow \eta$ has not been derived.

(d) Formula (VI.3) for entanglement scaling is a hypothesis requiring justification through the properties of the operator Φ on self-similar spaces.

(e) Gluons, weak bosons, and the photon require a separate interpretation within an extended formalism.

(f) The connection between PMNS angles and the loop geometry has not been formalized quantitatively.

10.3. Directions for further research

(a) Rigorous definition of Σ_d and proof of existence of self-similar fixed points.

(b) Derivation of quantum numbers (spin, isospin, color) from the components of the vector (B, A, H) .

(c) Quantitative relationship $(\pi - 3) \rightarrow \eta$.

(d) Formalization of PMNS angles through the loop geometry.

(e) Numerical modeling of $\delta\Psi$ on fractal structures analogous to [11, 12].

XI. CONCLUSION

The proposed interpretation of subatomic particles through the triadic architecture of ODTOE reveals structural consistency across nine parameters. The principle of recursive self-similarity (∞ -nesting) resolves the hydrogen stability paradox and formalizes the thesis of self-similarity of the act of observation at all scales — from sub-quark to cosmological. The reinterpretation of the Wheeler–Feynman hypothesis translates the one-electron idea from the language of spacetime to the language of observation operators, where the direct and inverse actions of the unified \hat{O} generate the electron and the positron as two phases of the self-observation cycle. Wheeler’s remark about positrons “hidden in protons” [3] acquires a literal meaning within the framework of ∞ -recursion.

The neutrino receives a fundamental interpretation as the helical gap $\delta\Psi = \Phi(\Psi) - \Psi$ — a materialization of the fundamental incompleteness of the strange loop closure. The three generations $(\nu_e, \nu_\mu, \nu_\tau)$ correspond to the three projections of $\delta\Psi$ onto the junctions of the triadic architecture; neutrino oscillations correspond to the rotation of the vector $\delta\Psi$ in the junction space; CP violation to the loop helicity ($\pi \neq 3$); the smallness of mass to the infinitesimality of the gap.

The atom emerges as an elementary strange loop — a fixed point of the self-observation mapping that reproduces its own architecture at each nesting level, while the neutrino is the irreducible ghost of its incompleteness.

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