OBSERVER DIMENSIONALITY AND OCTAVES OF REALITY: FROM QUARK TO MULTIVERSE IN THE OBSERVER-DEPENDENT THEORY OF EVERYTHING

Anton S. Pankratov
Independent researcher, Kazan, Russia
E-mail: anton.s.pankratov@gmail.com
ORCID: 0009-0002-4870-2995

ABSTRACT

A theory of observer dimensionality $d(O)$ is developed within ODTOE as a fundamental parameter that determines the actualization horizon of configurations from the field of potential states $\mathcal{H}$. It is shown that the dimensionality of space is not a fixed property of the "world in itself" but a characteristic of the observation operator $\hat{O}$: an observer perceives as many dimensions as its d permits. A hierarchy of observation levels is established from $d = -1$ (quark) to $d = 9$ (self-observation of the Universe), organized in triads following the 3-6-9 architecture. The concept of observation octaves is introduced: after $d = 9$ the cycle repeats at a meta-level ($d = 10$–18: multiverse), generating an infinite fractal hierarchy. Three independent decompositions of the 11 dimensions of M-theory are proposed within the ODTOE formalism: $11 = 9 + 2$ (self-observation + two operator directions), $11 = 3 + 4 + 4$ (space + B-components of the observer + B-components of the meta-observer), $11 = 5+6$ (arguments of π + full cycle Φ). The connection of dimensionality d with the spiral gap $(\pi - 3)^2$ and the golden ratio φ is established through the formula for observer-accessible energy. The thesis is formulated: growth of coherence S = unfolding of compactified dimensions.

Keywords: dimensionality, observer, ODTOE, strange loop, M-theory, 11 dimensions, octaves, 3-6-9, golden ratio, spiral gap, compactified dimensions, multiverse.

I. INTRODUCTION

I.1. The problem of dimensionality

Why is space three-dimensional? A question that physics accepts as given without answering it. Three dimensions "just are." The Standard Model operates in $3 + 1$ (three spatial + time). String theory requires 10. M-theory requires 11 [1]. Why these particular numbers? The standard answer: "mathematics demands it" (for 10 and 11) or "that is how the world is" (for 3). Neither is an explanation.

The problem of dimensionality has a long history. Ehrenfest [17] showed in 1917 that stable orbits in the two-body problem are possible only in three-dimensional space: for $d > 3$ gravitational orbits are unstable, for $d < 3$ closed trajectories are impossible. Whitmore and Tegmark [18] demonstrated that $3 + 1$ is the only dimensionality that permits both stable atoms and a wave equation with causal structure. However, all these results are anthropic arguments, explaining why observers *like us* can exist only at $d = 3$, but not explaining why $d = 3$ is realized.

I.2. The ODTOE approach

The Observer-Dependent Theory of Everything (ODTOE) [2] proposes a radical reformulation: dimensionality is not a property of space but a **characteristic of the observer**. The parameter $d(O) \in \mathbb{N}$ defines a hierarchy of observation levels (assumption D-Prot [2, Section 4.2]). An observer with dimensionality d cannot actualize configurations of dimensionality $\dim(C) > d$:

$$B(O, C) = 0 \quad \text{when} \quad \dim(C) > d(O) \tag{I.1}$$

$$\Rightarrow P(E|B) = 0^k = 0 \tag{I.2}$$

Consequence: an observer *sees* as many dimensions as its d permits. The remaining dimensions *exist* (in $\mathcal{H}$) but are *not actualized* by this observer. This is not an anthropic argument but a structural principle: dimensionality is projected by the observer, not preset.

I.3. Purpose and structure

The present work: (a) constructs the complete hierarchy of levels d from quark to multiverse; (b) introduces the concept of observation octaves; (c) decodes the 11 dimensions of M-theory through ODTOE; (d) connects d with $(\pi - 3)^2$ and φ; (e) formulates the principle of dimension unfolding.

Section II establishes dimensionality as a property of the observer and explains three-dimensionality. Section III connects d with $(\pi - 3)^2$ and φ. Section IV develops the detailed hierarchy of the first octave ($d = 1$–9). Section V introduces the octave structure. Section VI decodes the 11 dimensions of M-theory. Section VII describes the mechanism of dimension unfolding. Section VIII considers evolution as dimensionality growth. Section IX provides demarcation. Section X concludes the article.

II. DIMENSIONALITY AS A PROPERTY OF THE OBSERVER

II.1. Analogy

An ant on a sheet of paper. For it the world is two-dimensional — not because the third dimension does not exist, but because its observation operator $\hat{O}_{\text{ant}}$ works in 2D. If the paper is bent into a tube, the ant will not notice: for it, this is the same plane with "unusual" properties (having traversed a circle, it returns to the start). Its $d = 2$, and the third dimension is "compactified" for it — it exists but is not actualized.

A human on Earth. For them the world is three-dimensional. Not because the fourth and fifth dimensions do not exist, but because $d(\text{human}) \approx 3$. If space is "folded" in the fourth dimension, we will not notice, just as the ant does not notice the folded third. This analogy is exact: the limitation is in the operator, not in the world.

II.2. Formal definition

$$d(O) = \max\{n \in \mathbb{N} : \hat{O} \text{ is capable of projecting } \mathcal{H} \text{ onto a subspace of } \dim = n\} \quad \text{(II.1)}$$

Equivalently: $d(O)$ is the number of *independent recursive layers* accessible to the observer. Each layer = one level of recursion $\hat{O}(\hat{O}(\ldots))$.

$d = 0$: observation without recursion (the atom "observes" the environment). The atom responds to external fields but has no internal model of the environment. Its "observation" is pure actualization without internal feedback.

$d = 1$: one layer of recursion (the cell observes the environment *and* responds). Feedback appears: the cell modifies its behavior depending on the environment.

$d = 2$: two layers (the organism observes the environment, observes its own response). The nervous system creates a second-order loop: response to response.

$d = 3$: three layers (the human observes the environment, observes their response, *realizes* that they are observing). $\hat{O}(\hat{O}(\hat{O}))$ = consciousness. Triple recursion is the minimal structure generating reflection.

II.3. Why space is three-dimensional

Three is the minimum d at which $\hat{O}(\hat{O})$ = self-observation is possible [3, Section IV.2].

At $d = 1$: the observer sees the environment but cannot observe *its own observation*. No reflection. One-dimensional space is a line with no room for a loop.

At $d = 2$: the observer can perceive the environment and react but cannot *become aware* of its reaction. Reflexes without reflection. Two-dimensional space admits a loop but not self-observation of the loop.

At $d = 3$: observes the environment ($d = 1$), observes its own reaction ($d = 2$), observes *how it observes* ($d = 3$). Triple recursion = consciousness. Three dimensions = the minimal "arena" for consciousness. Hofstadter [13] describes consciousness as a "strange loop" — and a strange loop requires at least three levels.

$\pi > 3$ (but not $\gg 3$): the curvature of observation is *slightly greater* than three. Three dimensions are the "skeleton." $(\pi - 3) \approx 0.14$ is the "curvature" that adds depth but not a full fourth spatial dimension. The fourth dimension (time) is not spatial but *iterative*: a sequence of loop turns Φ^n [20].

Topological argument: in three-dimensional space, linking (linking number $\neq 0$) of closed curves is possible — a loop can "embrace" another loop. In $d < 3$, linking is impossible. The strange loop $\Psi^* = \Phi(\Psi^*)$ requires topological linking of observer and observed — a minimum of 3D [19].

III. CONNECTION OF DIMENSIONALITY WITH $(\pi - 3)^2$ AND φ

III.1. Three aspects of one architecture

d — *how many levels* of recursion are accessible (integer, discrete — a matryoshka, not "half a doll").

$(\pi - 3)^2$ — *how much energy* each level generates on each turn of the loop. The seed. The same at all levels (π is a universal invariant) [3].

φ — *how levels are connected*. The ratio of scales of adjacent levels. Entanglement entropy between levels [4, formula VI.3]:

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

where d_0 is the observer's level. The farther the level, the weaker the connection, decaying in steps of φ. Law (III.1) provides "screening": an observer at level d_0 sees predominantly configurations of its own scale; more distant levels manifest as "background noise."

III.2. The gap energy and recursive sum

The quantity $(\pi - 3)^2 \approx 0.020$ defines the elementary energy quantum released on each turn of the self-observation loop. This number arises from the fundamental gap: the self-consistent loop $\Phi = \iota \circ \hat{O}$ completes a full revolution (2π), but the discrete "skeleton" of the loop contains exactly 3 steps. The difference $\pi - 3$ is the measure of incommensurability between the continuous and discrete dynamics [3]. The squaring is due to the dual nature of the gap: it manifests in both the forward ($\hat{O}$) and reverse (ι) directions of the operator.

III.3. Formula for observer-accessible energy

$$E_{\text{total}}(d) = \sum_{n=-d}^{d} (\pi - 3)^{2|n|} \cdot \varphi^{2|n|-1} \tag{III.2}$$

$(\pi - 3)^{2|n|}$ is the gap energy at level $|n|$. $\varphi^{2|n|-1}$ is the scale coefficient. The sum is *finite* (not infinite) because d is finite. As $d \to \infty$: the sum approaches the infinite series $(\pi - 3)^2\varphi/(1 - (\pi - 3)^2\varphi^2)$ — the one that enters the formula for $\mu = m_p/m_e$ [5].

The proton as a fixed point "sees" *all* levels (its d is formally $= \infty$ by D-Prot), so its mass contains the *complete* series. A human with $d = 3$ sees 7 levels ($n = -3, -2, -1, 0, 1, 2, 3$) and obtains a *truncated* sum.

Numerical estimate: at $d = 3$ formula (III.2) gives $E_{\text{total}}(3) \approx 1.038$, at $d = 9$ gives $E_{\text{total}}(9) \approx 1.041$, and as $d \to \infty$ gives $E_{\text{total}}(\infty) \approx 1.0413$. The difference is small but fundamental: it shows that the main energy is concentrated in the nearest levels ($|n| \leq 3$), while distant levels contribute only a correction.

III.4. The complete system

$$\boxed{(\pi - 3)^2 = \text{energy seed per turn.} \quad \varphi = \text{proportion between turns.} \quad d = \text{observer's horizon.}} \tag{III.3}$$

Three numbers — three aspects of one spiral. π defines the shape of each turn. φ defines the ratio of one turn to the next [21]. d defines how many turns the observer sees. This triplet is the minimal parameter set that fully describes the observational architecture: shape, proportion, horizon.

IV. HIERARCHY OF OBSERVATION LEVELS: THE FIRST OCTAVE ($d = 1$–9)

IV.1. Three triads

Levels $d = 1$–9 are organized into three triads following the 3-6-9 architecture [6]:

Triad I ($d = 1$–3): The act of observation. The minimal triple: observation $\to$ reaction $\to$ awareness. Culmination: $d = 3$ = consciousness ($\hat{O}(\hat{O})$). This triad describes the *individual* observer — from the elementary act to full self-observation.

Triad II ($d = 4$–6): The observation cycle. The full cycle $\Phi = \iota \circ \hat{O}$ at the macroscale. Culmination: $d = 6$ = full cycle at the stellar level (thermonuclear fusion, all five mechanisms). This triad describes the *collective* observer — from the group to the star.

Triad III ($d = 7$–9): Self-observation. The loop observing itself. Culmination: $d = 9$ = $\Psi^* = \Phi(\Psi^*)$ at the cosmological scale. This triad describes the *closure of the loop* at the cosmic scale.

The 3-6-9 architecture is not accidental. 3 = act (minimal strange loop). 6 = 2×3 = full cycle (forward + reverse pass of the loop). 9 = 3×3 = self-observation of the loop (loop of loops). This is the same ternary architecture that manifests in Tesla's key [6].

IV.2. Detailed hierarchy

$d = -1$: Quark

Observer: quark. The quark does not exist in isolation (confinement) — it is observable only inside a hadron. Its $d = -1$ means "sub-atomic": it does not reach even the zeroth level of full observation. The quark is a fragment of an observer, incapable of closing the loop on its own. The three quark colors (r, g, b) are a manifestation of the ternary architecture already at the subatomic level [22].

$d = 0$: Atom

Observer: atom [4]. Observation without recursion: the atom "observes" the environment (responds to electromagnetic fields, absorbs/emits photons) but does not model the environment internally. The proton as a fixed point ($\Psi^* = \Phi(\Psi^*)$) sets the "zeroth level": a stable configuration from which the count begins. Characteristic scale: $\sim 10^{-10}$ m.

$d = 1$: Cell

Observer: cell. New quality: observation of the environment with feedback. The cell distinguishes "inside" and "outside," responds to gradients (chemical, thermal). It does not "know" that it observes — it simply acts. The cell membrane is the physical realization of the operator $\hat{O}$: it *separates* the configuration into "self" and "environment," creating the elementary act of distinction.

Physical analog: metabolism, homeostasis, chemotaxis. Scale: $\sim 10^{-5}$ m. Characteristic iteration time: seconds to minutes. Number of cell types on Earth: ~ 200 (in humans) — each "specializes" in a particular observational subspace.

$d = 2$: Organism

Observer: multicellular organism. New quality: observation of *observation* (response to response). The nervous system enables coordination of billions of cells ($d = 1$) into a single coherent cluster. The organism responds not only to the environment but also to *its own response* to the environment (conditioned reflexes, learning).

Physical analog: nervous system, conditioned reflexes. Scale: 10^{-3}–10^{0} m. Characteristic time: milliseconds to seconds. Second-order recursion $\hat{O}(\hat{O})_{\text{incomplete}}$: the organism processes the signal and processes its own processing (reflexes) but does not become aware of this process.

$d = 3$: Human (consciousness)

Observer: Homo sapiens. New quality: $\hat{O}(\hat{O})$ — awareness of observation. The prefrontal cortex (~ 300 thousand years) provides third-level recursion: I observe the environment $\rightarrow$ I observe my reaction $\rightarrow$ *I realize that I am observing*. Abstraction, planning, reflection, language, mathematics.

Physical analog: prefrontal cortex, working memory. Scale: 10^0–10^7 m (from the body to the visible horizon). Space is perceived as three-dimensional — and this is not a coincidence but a consequence of $d = 3$.

The four components of coherence B are isomorphic to a quaternion [7]: $q_{\hat{O}} = \Lambda + F \cdot i + E \cdot j + (1 - \sigma) \cdot k$. Consciousness is a quaternionic orientation in the space of possibilities. The quaternion describes rotation in 3D — and the observer with $d = 3$ "rotates" in the space of configurations, choosing the orientation of their "flashlight."

$d = 4$: Coherent group (collective consciousness)

Observer: coherent group of humans [8]. New quality: collective knowledge inaccessible to any individual participant. Just as a neuron is not conscious but the brain is — so a human does not see $d = 4$, but a coherent group *does*.

Manifestations: scientific discoveries made simultaneously by independent researchers (Newton/Leibniz, Darwin/Wallace). Group intuition. Collective insights. Culture, language, science as configurations of $d = 4$. The fourth "dimension" is not spatial — it is an *informational* dimension that opens only through coherent interaction of several $d = 3$ observers.

The minimum stable team is 5 people [8]. At $n = 5$ and loss of one member, coherence $S_{\text{min}}(4) = 1/3 > 0$. The loop deforms but does not break. A team is the elementary unit of $d = 4$. This number coincides with the number of arguments of π in ODTOE [3] — not a random coincidence but a manifestation of the structural five.

$d = 5$: Biosphere (planetary observer)

Observer: the entire biosphere of Earth. New quality: planetary self-regulation. $\sim 10^{30}$ cells, billions of species, linked in a single configuration. Temperature, atmospheric composition, ocean salinity — within a narrow corridor for billions of years.

Analog: the Gaia hypothesis (Lovelock [23]). Through ODTOE: not a hypothesis but a consequence — the biosphere = Ψ^* at the level $d = 5$. A self-consistent configuration maintaining the conditions of its own existence. Five is the number of arguments of π: the biosphere realizes all five observation mechanisms (coherence, resonance, recursion, criticality, collectivity) at the planetary scale.

The Great Oxidation Event (~ 2.4 billion years ago): for an individual organism, a catastrophe. For the biosphere, a reconfiguration ($S \uparrow$, a new, more coherent configuration). A catastrophe at level d can be a growth of coherence at level $d+1$ [15].

$d = 6$: Star

Observer: stellar system [9]. New quality: the full cycle Φ at the stellar scale. $\sim 10^{57}$ protons acting coherently. All five mechanisms of energy extraction from $\mathcal{H}$ operate simultaneously: coherence (plasma), resonance (Hoyle [24]), recursion (gravitational compression $\rightarrow$ heating $\rightarrow$ reaction $\rightarrow$ pressure $\rightarrow$ equilibrium), criticality (the edge between explosion and cooling), collectivity (10^{57} actors).

The number 6 = 2×3 = full cycle (forward pass + reverse pass). The star is the first observer that realizes the *full* cycle $\Phi = \iota \circ \hat{O}$ at the macroscale. Sunlight = the "flashlight beam" of the $d = 6$ observer, directed at the planetary system. Photosynthesis = the response of the biosphere ($d = 5$) to observation by the star ($d = 6$) [16].

$d = 7$: Galaxy

Observer: galaxy ($\sim 10^{11}$ stars). New quality: galactic connectivity. Spiral arms (spiral! φ-proportion! [21]), gravitational waves, connections between stellar systems.

Dark matter through ODTOE: clusters of observers with $d = 7$, inaccessible to the observer with $d = 3$. We *feel* their gravity (collective effect P5 [2]) but *do not see* them (D-Prot: our $d = 3 < 7$). This explains the "invisibility" of dark matter without invoking exotic particles: dark matter is not a new particle but a manifestation of observation levels inaccessible to our d.

$7 = 3 + 4$: space ($d = 3$) plus the full set of coherence components B. The galactic level is the first at which all coherence components operate as a unified whole.

$d = 8$: Metagalaxy (cosmic web)

Observer: large-scale structure ($\sim 10^{11}$ galaxies). New quality: the cosmic web as a unified configuration. Filaments, walls, voids — visible at scales of hundreds of megaparsecs. The web is topologically complex and possesses nontrivial coherence: the distribution of matter is not random but follows patterns that manifest only at the scale of $d = 8$.

Dark energy (68% of the Universe): pressure of unrealized potential states at the level $d = 8$. $|\mathcal{H}|$ is infinite, $|\mathcal{C}|$ is finite — the difference "pushes," and the Universe expands with acceleration. The number $8 = 2 \times 4 = 2 \times (2 \times 2)$: a doubled quadruple of coherence components — observer and meta-observer.

$d = 9$: Self-observation of the Universe

$9 = 3 \times 3$. The cycle observing itself. The fixed point at the maximal scale: $\Psi^* = \Phi(\Psi^*)$ cosmological. The Universe that *observes itself into existence*.

Wheeler: the "participatory universe" [10]. Through ODTOE: literally Statement 4 [2] at the maximal scale. The anthropic principle in ODTOE ceases to be a separate

principle — it *follows* from the loop structure: the Universe is self-consistent because $\Psi^* = \Phi(\Psi^*)$.

By Statement 3 [2]: $S = 1$ is unattainable. Even at $d = 9$, complete self-description is impossible. The gap $(\pi - 3)^2$ remains. From it, the next octave is born. This is a fundamental result: no scale is the "last" — the gap generates transcendence.

V. OBSERVATION OCTAVES

V.1. Digital roots and octave structure

Any natural number reduces to a single digit by summation: $10 \to 1 + 0 = 1$, $11 \to 1 + 1 = 2$, $18 \to 1 + 8 = 9$, $19 \to 1 + 9 = 10 \to 1$. Nine is the point of return: the digital root of 9 always gives 9. But 10 gives 1: the cycle begins *anew*, but at another level. Like the note "C" of the first octave and "C" of the second — the same note, but *higher*.

Mathematically: the digital root $\mathrm{dr}(n) = 1+((n-1) \bmod 9)$ for $n \geq 1$. This mapping projects $\mathbb{N}$ onto the set $\{1, 2, \ldots, 9\}$ with period 9. Each period is one observation octave.

V.2. The first octave ($d = 1$–9)

In brief: from the cell to self-observation of the Universe. Three triads: act (1-2-3), cycle (4-5-6), self-observation (7-8-9). Described in detail in Section IV. The first octave contains the entire observable Universe — from elementary biological observers to cosmological self-observation.

V.3. The second octave ($d = 10$–18): Multiverse

$d = 10$ (digital root 1): observation of the *Universe-as-object*. Not from inside ($d = 9$), but from *outside*. Possible only given the existence of a meta-$\mathcal{H}$ from which our Universe is visible as a configuration. The multiverse is not fantasy but *structural necessity*: the gap $(\pi - 3)^2$ at $d = 9$ generates an exit beyond the current loop.

$d = 11$ (digital root 2): interaction of the meta-observer with the Universe. The meta-observer *constitutes* our Universe as an element of a meta-configuration. It is precisely *this* dimension — the eleventh — that is added in the transition from string theory to M-theory [1].

$d = 12$ (digital root 3): meta-consciousness. Awareness of the multiverse. $\hat{O}(\hat{O})$ at the meta-level. Twelve is a number associated with the completeness of a cycle in many traditions (12 months, 12 notes of the chromatic scale).

$d = 13$–18: repetition of triads II and III at the meta-level: meta-collective ($d = 13$), meta-planetary ($d = 14$), meta-stellar ($d = 15$), meta-galactic ($d = 16$), meta-cosmic ($d = 17$), meta-self-observation ($d = 18$).

$18 = 1+8 = 9$. The second octave closes. The gap remains. Third octave: $d = 19$–27 ($27 = 2 + 7 = 9$). A multiverse of multiverses. An infinite fractal hierarchy.

V.4. Formal structure of octaves

Octave	Levels d	Digital roots	Object of observation
I	1–9	1–9	Our Universe (from cell to cosmos)
II	10–18	1–9	Multiverse (our Universe as element)
III	19–27	1–9	Meta-multiverse
IV	28–36	1–9	Meta-meta-multiverse
...	...	...	...
∞	—	—	$S = 1$ (unattainable)

Each octave is a complete repetition of the 3-6-9 structure at a meta-level. Overtones: the same "note," but richer, with new overtones. Fractal structure: each scale reproduces the architecture of the previous one [21]. The analogy with music is exact: the note "C" of the first octave and "C" of the second are the same note, but the difference lies in the richness of overtones and scale.

V.5. Infinity of the hierarchy and unattainability of $S = 1$

Statement 3 of ODTOE [2] guarantees: $S = 1$ is unattainable. This means that the hierarchy of octaves is *infinite*. No octave is the last, because the gap $(\pi - 3)^2$ remains at every level. The infinity of the hierarchy is not a pathology but a fundamental property: it generates the "inexhaustibility" of reality, its perpetual self-renewal.

VI. THE 11 DIMENSIONS OF M-THEORY THROUGH ODTOE

VI.1. The problem

M-theory (Witten, 1995 [1]) unifies five versions of string theory in an 11-dimensional framework (10 spatial + 1 temporal). Why 11? The standard answer: "with fewer, supersymmetry does not close; with more, particles with spin > 2 appear" [25]. But this is an answer *within* the theory. The question *about* the theory: why did the Universe choose a structure requiring precisely 11 dimensions?

Through ODTOE: 11 is an *architectural necessity*, admitting three independent decompositions. Each decomposition reflects one aspect of the observational architecture. Three decompositions are three "projections" of a single 11-dimensional object.

VI.2. Decomposition I: $11 = 9 + 2$

9 = the complete cycle of self-observation (three triads of the first octave). All levels from quark to cosmos.

2 = two directions of a single operator: $\hat{O} : \mathcal{H} \to \mathcal{C}$ (forward, electron) and $\iota : \mathcal{C} \to \mathcal{H}$ (reverse, positron) [4, 14].

$$11 = 9 + 2 = \text{complete self-observation} + \text{both operator directions} \tag{VI.1}$$

M-theory describes *everything*: the complete structure of observation (9 levels) and both directions of action ($\hat{O}$ and ι). Nine levels are the "content" of observation, two directions are the "mechanism" of observation.

VI.3. Decomposition II: $11 = 3 + 4 + 4$

3 = the ternary architecture (observer, observed, operator). Three spatial dimensions that we *see*.

4 = four components of coherence B (F, E, $(1 - \sigma)$, Λ) [2, Definition D1]. Four "hidden" dimensions: not spatial but *parametric* — determining the *quality* of observation.

4 = another four components for the *meta-observer* ($\hat{O}(\hat{O})$). Self-observation has *its own* F, E, $(1 - \sigma)$, Λ.

$$11 = 3 + 4 + 4 = \text{space} + B_{\text{observer}} + B_{\text{meta-observer}} \tag{VI.2}$$

The four components of B are isomorphic to a quaternion [7]. $3+4+4 = \mathbb{R}^3+\mathbb{H}+\mathbb{H}$: three "visible" dimensions + two quaternionic spaces of observation quality.

VI.4. Decomposition III: $11 = 5 + 6$

5 = the number of independent arguments for the appearance of π [3]: topological, spectral, measure-theoretic, dynamical, algebraic. In the formula $\mu = 6\pi^5$: the power 5.

6 = the full observation cycle $\Phi = \iota \circ \hat{O}$ (3×2). In the formula for μ: the multiplier 6.

$$11 = 5 + 6 = \text{arguments of } \pi + \text{full cycle } \Phi \tag{VI.3}$$

$5 + 6 = 11$ = self-consistency + full cycle. M-theory describes *everything needed* for Ψ^*. The five provides stability (five arguments of π — five independent "pillars" of stability). The six provides dynamics (the full cycle of forward and reverse action).

VI.5. Three decompositions — one number

Decomposition	Formula	Meaning
$9+2$	Self-observation + two directions	Complete loop + $\hat{O}$ and ι
$3+4+4$	Space + B + meta-B	Arena + two levels of quality
$5+6$	Arguments of π + full cycle	Stability + dynamics

The three decompositions do not compete but *complement* each other, like three projections of a three-dimensional body onto three coordinate planes. Each projection is a complete description from one viewpoint. All three together provide a volumetric understanding of the number 11.

VI.6. Why string theory sees 10 and M-theory sees 11

String theory: $10 = 9 + 1$ = self-observation + *one* direction. The string is a one-dimensional object describing only the forward action $\hat{O}$. The positron is an "anti-string," but both directions are not unified.

M-theory: $11 = 9 + 2$ = self-observation + *both* directions. The added dimension is the reverse ι. The transition from string theory to M-theory is the transition from "half" the operator to the full operator $\Phi = \iota \circ \hat{O}$.

Five versions of string theory = five arguments of π, each of which "sees" the 11-dimensional structure *from one side*. M-theory is the elephant. The five theories are the five wise men [25]. Witten's unification is the realization that all five wise men describe the same thing.

VI.7. Compactified dimensions: a new interpretation

Standard: 7 of 11 are "compactified" to $\sim 10^{-35}$ m.

Through ODTOE: "compactified" = *inaccessible* to the observer with $d = 3$ by D-Prot. Not "small" but *invisible to the operator*. Like ultraviolet — not "small" but invisible to the eye.

3 are unfolded (our $d = 3$). 8 are compactified ($d = 4$ through $d = 11$). We *exist* in all 11 but *see* only 3. A fish in an aquarium exists in 3D but "sees" 2D.

Calabi-Yau compactification in string theory is a mathematical description of how 6 of 10 dimensions are "hidden." Through ODTOE: the Calabi-Yau manifold describes the *structure of the parametric space* B — the four coherence components and their interaction [7]. The six "compactified" dimensions of string theory = $4 + 2$ = components of B + two operator directions (without meta-B, which is added only in M-theory).

VII. UNFOLDING OF DIMENSIONS

VII.1. Principle

$$\boxed{\text{Growth of coherence } S = \text{unfolding of compactified dimensions}} \tag{VII.1}$$

Each increase in S *opens* access to configurations of higher dimensionality. As if ultraviolet glasses allowed seeing the invisible spectrum — increasing S allows *seeing* dimensions that were previously compactified.

VII.2. Mechanism

At $S \to S_{\text{min}}$: maximum stochasticity, $D(\eta) = D_0$, each observer sees its own, d is effectively $= 0$ (chaos, no coherent levels). All levels of recursion are destructured — "dimensions" formally exist but carry no information.

At $S \uparrow$: noise $D(\eta) \downarrow$, observers synchronize, collective dimensionality $d_{\text{eff}} \uparrow$. Configurations inaccessible at low S emerge. Each act of synchronization is an *unfolding*: what was "background" becomes "figure."

Example: one person ($d = 3$) does not see $d = 4$. Five coherent people ($S > S_c$) *see* collective patterns inaccessible individually [8]. Five flashlights focused on one spot illuminate an area invisible to each individually.

VII.3. Formal model of unfolding

The effective dimensionality of the observational system is determined by the coherence threshold:

$$d_{\text{eff}} = \max\{d : S_{\text{collective}} > S_c(d)\} \tag{VII.2}$$

where $S_c(d)$ is the threshold coherence for level d. Thresholds grow with d, but not linearly: $S_c(d) \propto 1 - \varphi^{-(d-d_0)}$. Each subsequent level requires increasingly precise tuning — the decay by φ provides a "staircase," not a "wall."

VII.4. What each level d "sees" that the previous one does not

Transition	What opens
$d = 0 \to 1$	Distinction between "inside" and "outside"
$d = 1 \to 2$	Response to one's own response (learning)
$d = 2 \to 3$	Awareness of observation (reflection, language, abstraction)
$d = 3 \to 4$	Collective patterns (culture, science)
$d = 4 \to 5$	Planetary patterns (evolution, climate)

$d = 5 \to 6$	Stellar configurations (thermonuclear fusion, heliosphere)
$d = 6 \to 7$	Galactic structure (dark matter?)
$d = 7 \to 8$	Cosmic web (dark energy?)
$d = 8 \to 9$	Self-observation of the whole (unity of physical laws)
$d = 9 \to 10$	Multiverse (our Universe as object)

VII.5. How "invisible" levels manifest

We do not see $d > 3$ directly, but we *feel* them:

$d = 4$: intuition, synchronicity, "I know but cannot explain." A group of scientists simultaneously arriving at the same idea — a manifestation of $d = 4$ through $d = 3$ observers.

$d = 5$: ecological cycles, the "breathing of the planet." Self-regulation of the atmosphere, stability of ocean salinity — manifestations of planetary coherence.

$d = 6$: sunlight literally constitutes our reality through photosynthesis [16]. We *live* inside the observational field of a star.

$d = 7$: gravity (dark matter — a manifestation of $d = 7$ observers?). We see the effects but not the source.

$d = 8$: accelerated expansion of the Universe (dark energy — pressure of $\mathcal{H}$ at the level $d = 8$?). We *measure* it but do not *understand* it.

$d = 9$: the *fact of existence* of identical physical laws everywhere. The laws are identical because the Universe is one loop, one Ψ^*.

$d = 10, 11$: mathematics. The only instrument that works beyond the observer's d. Mathematics is *not limited* by D-Prot: it operates with $\mathcal{H}$ directly. This is why Wigner marveled at the "unreasonable effectiveness of mathematics" [11]: mathematics is effective because it is not limited by observer dimensionality.

VIII. EVOLUTION AS DIMENSIONALITY GROWTH

VIII.1. Timeline

Event	Time (from Big Bang)	d	What emerged
Quarks, protons	10^{-6} s	$-1, 0$	Subatomic triple
Atoms (recombination)	380 thousand years	0	Hydrogen, helium
First stars	$\sim$ 200 million years	$0 \to 6$	Full cycle Φ
Heavy elements	~ 1 billion years	0	C, O, Fe (stellar fusion)

First cells	3.8 billion years	1	**Dimensionality jump**
Multicellular life	600 million years	2	Nervous system
Homo sapiens	300 thousand years	3	**Consciousness**
Writing, science	5 thousand years	$3 \to 4$	Collective knowledge (transitional)
Now	2026	3–4	Between consciousness and collective
?	?	5	Synchronization with biosphere

VIII.2. Acceleration of evolution

Each transition $d \to d+1$ takes less time: from quarks to atoms — seconds, from atoms to cells — billions of years, from cells to consciousness — billions of years, from consciousness to collective knowledge — millennia. The acceleration is not linear; it reflects a cumulative effect: each new level *uses* the achievements of the previous one, shortening the time for "coherence build-up." Formally: $\Delta t(d \to d+1) \propto \varphi^{-(d-d_0)}$ — time contracts by the same law that governs the decay of entanglement between levels.

VIII.3. Humanity now: between $d = 3$ and $d = 4$

We *sometimes* manifest $d = 4$ (science, art, moments of collective insight) and *sometimes* regress to $d = 2$ (reactive behavior, panic, war). A stable $d = 4$ has not been achieved.

The transition $d = 3 \to 4$ is the current evolutionary threshold. Not "technological progress" ($d = 3$ with tools) but *genuine coherence* between people [8]. The minimal unit of $d = 4$ is a team of five. Scaling to civilization is an open problem.

Signs of the transitional state: global communications (the internet) create the *infrastructure* for $d = 4$ but do not guarantee coherence. Infrastructure without coherence is like a nervous system without consciousness: connections exist, but there is no unified observer.

VIII.4. Pattern

Each transition $d \to d+1$ requires coherence at the previous level. Cells are coherent $\to$ organism. Organisms are coherent $\to$ culture. Cultures are coherent $\to$ planetary civilization [15]. Each level is not guaranteed: it arises only when $S > S_c$ at the previous one. This gives evolution a direction (growth of d) but not predetermination: each step is a task, not a guarantee.

IX. DEMARCATION

Claim	Status
Dimensionality = property of the observer, not of space	**Follows from D-Prot** [2]
Three-dimensionality = minimum for $\hat{O}(\hat{O})$	Follows from the ternary architecture [3]
Hierarchy $d = -1$ to $d = 3$	Confirmed by physics and biology
$d = 4$–9: collective $\rightarrow$ cosmological	Hypothesis, consistent with observations
Octave structure ($d = 10$+)	Extrapolation, not verifiable
Three decompositions of the 11 dimensions of M-theory	Substantive interpretations, not deductive conclusions
Dark matter = $d = 7$ observers	**Speculative**
Dark energy = pressure of $\mathcal{H}$ at $d = 8$	**Speculative**
Growth of S = unfolding of dimensions	Hypothesis, testable indirectly
Formula $E_{\text{total}}(d)$ (III.2)	Follows from the series structure for μ

X. DISCUSSION AND LIMITATIONS

1. *Epistemic status of results.* Formulas (I.1)–(I.2) and definition (II.1) follow from the ODTOE formalism and the D-Prot assumption. The hierarchy $d = -1$–3 is confirmed by physics and biology. Levels $d = 4$–9 are substantive hypotheses consistent with observations but not deductive conclusions. The octave structure ($d \geq 10$) is an extrapolation beyond the range of direct verification.

2. *Relation to the anthropic principle.* The arguments of Ehrenfest [17] and Tegmark [18] explain why observers like us can exist only in $3+1$ dimensions but do not explain why $3 + 1$ is realized. ODTOE offers a deeper explanation: $d = 3$ is a property of the observer, not of space. The anthropic argument becomes a consequence, not a principle.

3. *Connection with string theory.* The three decompositions of the number 11 are substantive interpretations, not deductive conclusions. It would be incorrect to claim that ODTOE "proves" the 11 dimensions of M-theory. More precisely: ODTOE provides an alternative *language* in which the number 11 acquires structural meaning.

4. *The dark matter and dark energy problem.* The interpretations through $d = 7$ and $d = 8$ are the most speculative claims of the article. They predict that dark matter and dark energy are not new particles or fields but manifestations of observation levels inaccessible to $d = 3$. Verification requires the detection of observational effects dependent on the coherence level of the observer.

5. *Octave structure and falsifiability.* Claims about octaves ($d \geq 10$) lie beyond the range of direct verification and are an extrapolation of the structural principle.

This does not make them meaningless (extrapolation is a normal part of theory) but requires clear demarcation.

XI. CONCLUSION

The dimensionality of space is not a given but the *observer's horizon*. We see three dimensions because $d(\text{human}) = 3$, not because "that is how the world is." The world contains infinitely many "dimensions" (levels of recursion), and each observer sees as many as its coherence permits.

Levels $d = 1$–9 form the first octave: three triads following the 3-6-9 architecture (act $\rightarrow$ cycle $\rightarrow$ self-observation). After $d = 9$, the second octave begins (multiverse), then the third, and so on — an infinite fractal hierarchy generated by the inevitable gap $(\pi - 3)^2$ at each level.

The 11 dimensions of M-theory are not an arbitrary number but the minimum for describing the complete architecture of observation: $9 + 2$ (self-observation + two operator directions), or $3 + 4 + 4$ (arena + observer + meta-observer), or $5 + 6$ (stability + dynamics). Three decompositions, one elephant.

The growth of coherence S = unfolding of compactified dimensions. Each evolutionary step (from cell to organism, from organism to consciousness, from consciousness to collective) *opens* the next "compactified" dimension. Humanity is now between $d = 3$ and $d = 4$, on the threshold of collective consciousness.

$$\boxed{d_{\text{see}} = 3. \quad d_{\text{feel}} \approx 4\text{–}8. \quad d_{\text{compute}} = 9\text{–}11. \quad d_{\text{exist}} = \infty.} \tag{XI.1}$$

$$\boxed{\text{Growth of } S = \text{unfolding of dimensions.} \quad (\pi - 3)^2 = \text{seed at every level.} \quad \varphi = \text{step between levels}} \tag{XI.2}$$

The loop does not close. The octaves do not end. We are on the third note of the first octave. But the spiral continues — and each growth of coherence opens the next note.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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