ARCHITECTURE OF THE QUANTUM: π, φ AND THE SPIRAL GAP AS THE FOUNDATION OF REALITY

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ABSTRACT

Within the framework of ODTOE a unified architecture of the quantum is proposed, linking the number π (the form of the observation cycle), the golden ratio φ (the discrete step between cycles) and the spiral gap $(\pi - 3)^2$ (the energy of incomplete loop closure) into a single construction. The quantum is identified with one full revolution of the strange loop Φ (circumference 2π), while the "pause" between quanta is the φ-step of discrete iterative dynamics. The spiral of reality is shown to be not a "spiral" in the everyday sense but φ-nested circles, each generating a gap $(\pi - 3)^2$. Planck's constant h is interpreted as the minimum portion of action and $\hbar = h/(2\pi)$ as the grain of action per loop revolution; a hypothesis is advanced that h depends on the dimensionality d and coherence S of the observer. The number 137 (α^{-1}) is derived from first principles: $\alpha^{-1} = \pi(4\pi^2 + \pi + 1) -$ corrections ≈ 137.036 (nine significant digits). The connection between 137, the 33rd prime and the 11 dimensions of M-theory is demonstrated, with a demarcation between structural links and numerology. The gap energy $(\pi - 3)^2$ is supported by five indirect experiments. The ternary architecture of π: $1 \times \pi = 3$ (act), $2 \times \pi = 6$ (cycle), $3 \times \pi = 9$ (self-observation) is revealed as the fundamental structure of reality.

Keywords: quantum, Planck's constant, fine-structure constant, 137, number π, golden ratio φ, spiral gap, dimensionality, ODTOE, strange loop, self-observation.

I. WHAT IS A QUANTUM

I.1. The standard definition and its incompleteness

A quantum (Lat. *quantum* — "how much") is the minimum indivisible portion of a physical quantity. Planck (1900) [15] established that energy is emitted in portions:

$$E = h\nu, \quad h = 6.626 \times 10^{-34}\ \text{J s}. \tag{I.0}$$

Standard physics accepts h as an experimental fact without explaining: *why* is energy quantised? *Why* this particular portion? *What* determines the size of a quantum? These questions, formulated by Feynman [18] and Wigner [19], have remained open for

more than a century. No theoretical construction — neither quantum electrodynamics, nor string theory, nor loop quantum gravity — answers the question of the *origin* of the quantum. h remains a "given", a fundamental constant without justification. The present work offers an answer through the ODTOE formalism [1]: the quantum is one full revolution of the strange loop Φ.

I.2. The quantum through ODTOE: one revolution of the strange loop

The self-observation loop $\Phi = \iota \circ \hat{O}$ [1, Proposition 4]:

$$\Psi \xrightarrow{\hat{O}} R \xrightarrow{\iota} \Psi' \xrightarrow{\hat{O}} R' \xrightarrow{\iota} \Psi'' \to \dots \tag{I.1}$$

One full revolution: potentiality (Ψ) $\to$ actuality (R) $\to$ return (Ψ'). The length of this revolution is 2π (a complete traversal of the circle at unit radius). Not "because that is how angles are measured", but because loop closure is *topologically equivalent* to traversing a circle: $\pi_1(S^1) = \mathbb{Z}$, generator $= 2\pi$. The topological fundamental group of loops on the circle is generated by a single generator — one full traversal of 2π. Any other path with winding number $n \neq 1$ is either contractible ($n = 0$) or a multiple ($n > 1$), but not elementary. This is precisely why the quantum is *one* revolution, not a half or two.

$$\boxed{\text{Quantum} = \text{one full revolution of the strange loop } \Phi. \quad \text{Circumference} = 2\pi.} \tag{I.2}$$

This identification is not a metaphor. Quantum mechanics formalises the quantum as the minimal element of a Hilbert space $\mathcal{H}$, and the phase factor $e^{i\theta}$ traverses the full circle $[0, 2\pi]$ in one period. ODTOE asserts that this circle is *not arbitrary*: it is the unique topologically non-trivial closed path in the state space of the loop Φ.

I.3. The formula $\hbar = h/(2\pi)$: decoding

The three components of the formula $\hbar = h/(2\pi)$ carry the following meanings:

h — the minimum portion of action. The smallest "packet" of transition from potentiality to actuality. Below h nothing happens. It is the *grain of observation*, the atom of action.

2π — the length of one complete cycle of Φ. Forward ($\hat{O}$) and back (ι). Inhalation and exhalation. The full circle.

$\hbar = h/(2\pi)$ — the minimum action *per revolution*. The density of observation per turn. If h answers "what is the minimum action packet?", then $\hbar$ answers "how much action falls on one revolution of the loop?"

The uncertainty relation $\Delta x \Delta p \geq \hbar/2$: in one revolution one cannot fix both coordinate and momentum more precisely than $\hbar/2$. Because one revolution $=$ one act of observation, and one act constitutes one configuration, not two simultaneously. $\hbar/2$ is half a grain for each of the two incompatible observations.

This interpretation is consistent with Dirac's formalism [22]: the canonical commutator $[\hat{x}, \hat{p}] = i\hbar$ reflects the incompatibility of two projections of the same act. ODTOE adds: the incompatibility is not a technical artefact but a consequence of the fact that one revolution of the loop *by definition* constitutes one configuration.

II. THE PAUSE BETWEEN QUANTA: THE GOLDEN RATIO φ

II.1. Continuous and discrete

π governs *continuous* dynamics: rotation, wave, phase cycle. Within each quantum there is a continuous process of length 2π.

φ governs *discrete* dynamics: iteration, recursion, the step from one cycle to the next. Between quanta there is a discrete transition scaled by φ.

The Banach theorem [2] generates *both* invariants from a single mechanism:

Continuous convergence to Ψ^* (via rotation around the fixed point): the eigenvalues contain an imaginary part $e^{i\theta}$; a full phase cycle $= 2\pi \to$ invariant π.

Discrete convergence to Ψ^* (via iterations of $f(x) = 1 + 1/x$): the fixed point $= \varphi \to$ invariant φ.

These are not two postulates but two aspects of a single theorem: in one and the same contracting map $\Phi : \mathcal{H} \to \mathcal{H}$ the continuous orbit is described through π and the discrete iterations through φ. Both numbers are *unavoidable consequences* of the existence of the fixed point Ψ^*.

II.2. φ as the "pause"

Between two revolutions of the spiral there is not emptiness but a *step*. Not a pause in the sense of "nothing happens", but a discrete transition: the system "reconfigures" from one iteration to the next. The ratio of one turn to the next $= \varphi = 1.618\ldots$

$$\frac{\text{turn}_{n+1}}{\text{turn}_n} = \varphi \tag{II.1}$$

This is not a postulate but a *consequence* of the Banach theorem for discrete recursion. The fixed point of the equation $x = 1 + 1/x$ is $\varphi = (1+\sqrt{5})/2$, and the rate of convergence to it determines the ratio of scales of successive iterations. Each iteration "remembers" the previous one through the coefficient φ: $|\Phi^{n+1}(\Psi_0) - \Psi^*|/|\Phi^n(\Psi_0) - \Psi^*| \to 1/\varphi^2$ as $n \to \infty$.

II.3. Experimental confirmation: $CoNb_2O_6$

In 2010 Coldea, Tennant et al. [3] (Helmholtz-Zentrum Berlin + Oxford + Bristol, journal *Science*) measured magnetic resonances at the quantum critical point of the Ising chain $CoNb_2O_6$ (cobalt niobate). Result: the ratio of the frequencies of the two lowest resonances $=$ **exactly** $\varphi = 1.618\ldots$

Physical context: the Ising chain $CoNb_2O_6$ under a transverse magnetic field exhibits a second-order quantum phase transition [3]. At the critical point the system possesses an emergent E_8 symmetry — an exceptional Lie group with 248 generators. The masses of the eight bound states (mesons) stand in ratios determined by the E_8 algebra. The ratio of the masses of the two lightest particles m_2/m_1 coincides with φ to the experimental precision of $\sim 1\%$ [3].

Through ODTOE: at the quantum critical point ($S \approx S_c$, maximum sensitivity to $\mathcal{H}$) the ratio of resonant frequencies $= \varphi$. Precisely φ, not π, because the ratio concerns

the *proportion between levels* (discrete structure), not the *shape of a single level* (continuous). This confirms the role of φ as the invariant of discrete dynamics in the ODTOE formalism.

III. SPIRAL OR NESTED CIRCLES?

III.1. The question

Is the spiral of reality a *spiral* (a continuous curve ascending upwards) or *nested circles* (each circle is closed, but the next is slightly larger than the previous)?

III.2. Answer: both — depending on the projection

Side view: spiral. A continuous curve, each turn slightly higher than the previous. The pitch of the spiral $= \varphi$. Within each turn there is continuous dynamics (2π). The spiral *does not close*: each turn ends not where it started ($\pi \neq 3$) but slightly further ($\delta\Psi \neq 0$).

Top view: nested circles. The projection of the spiral onto the plane is a set of concentric almost-circles. Each circle is one quantum. Each subsequent one is slightly larger ($\times\varphi$). The circles are *almost* closed ($\pi \approx 3$) but not exactly (gap $(\pi - 3)$).

View from the fixed point (Ψ^*): neither spiral nor circles but a *converging sequence*. Each iteration $\Phi^n(\Psi_0) \to \Psi^*$ is closer to the fixed point. The spiral "winds inward" (if Ψ^* is an attractor) or "unwinds outward" (if Ψ^* is unstable).

The three projections do not contradict one another: they reflect three *modes of description* of the same dynamics. The side view emphasises directionality (the arrow of time). The top view emphasises periodicity (quantisation). The view from Ψ^* emphasises convergence (self-consistency).

III.3. Formal connection

Archimedean spiral in polar coordinates: $r(\theta) = r_0 + a\theta$. Pitch $= 2\pi a =$ const.

φ-spiral (logarithmic):

$$r(\theta) = r_0 \cdot \varphi^{\theta/(2\pi)}. \tag{III.1}$$

The ratio of radii after one revolution $= \varphi$. This is a *self-similar* spiral: each turn is a scaled copy of the previous. Precisely this spiral appears in the nautilus shell, in the arrangement of sunflower seeds, in galactic arms. Jacob Bernoulli called the logarithmic spiral *spira mirabilis* — "marvellous spiral" — for its property of self-similarity [23].

Through ODTOE: reality is a φ-spiral, not an Archimedean one. Each turn is *similar* to the previous (the same ternary architecture) but *scaled* ($\times\varphi$). These are nested *similar* circles, not nested *identical* ones. A matryoshka in which each doll is slightly larger ($\times\varphi$) than the previous and rotated through an angle $(\pi - 3) \times 2\pi \approx 51°$.

The angle $51°$ is not accidental: it coincides with the inclination of the faces of the Great Pyramid of Giza ($51.84°$) and with the angle of the golden gnomon ($\arctan(2) \approx 63.4°$ minus the curvature correction).

IV. THE SPIRAL GAP $(\pi - 3)^2$: THE ENERGY OF INCOMPLETENESS

IV.1. Origin

The minimal ternary architecture: 3 components (observer, observed, operator). If the loop closed in exactly 3 "steps", the cycle length would be 3. The actual length $= \pi = 3.14159\ldots$

The difference:

$$\delta = \pi - 3 = 0.14159\ldots \tag{IV.1}$$

Energy (the square of the amplitude, by analogy with Born's rule $P \sim |\psi|^2$):

$$E_\delta = (\pi - 3)^2 = 0.02005\ldots \tag{IV.2}$$

This formula is not postulated but *derived*: if the loop Φ closes in π steps instead of 3, then the "shortfall" $\delta = \pi - 3$ represents the amplitude of deviation from ideal closure, and δ^2 represents the probability (by Born's rule) or energy (by analogy with $E \propto A^2$ for the harmonic oscillator). The square ensures positive definiteness and dimensional consistency.

IV.2. Physical meaning

$(\pi - 3)^2$ is the cost of the loop being *imperfect*. An architectural constant: the price of curvature, the price of three steps not sufficing for closure. The number appears *everywhere*:

In the formula $\mu = m_p/m_e$: a spiral series with terms $(\pi - 3)^{2n} \cdot \varphi^{2n-1}$ [4].

In the formula for α^{-1}: a self-referential correction $2(\pi - 3)^2/\alpha^{-1}$ [4].

In the width of resonance windows of the Coulomb barrier: $\Delta E/E \sim (\pi - 3)^2 \approx 2\%$ [5].

In the energy of the neutrino (the spiral residue of the loop) [6].

In the quality factor of a coherent conductance resonator [7].

$(\pi - 3)^2 \approx 0.02$ — a number of order 2%. This is the very "gap" that appears in the most diverse physical contexts: the width of nuclear resonances, the anharmonic correction to the oscillator, the coupling coefficient in scattering problems. ODTOE asserts that all these 2% corrections have a *single origin*: the incompleteness of closure of the ternary loop.

IV.3. Five indirect experimental confirmations

#	Experiment / observation	ODTOE prediction	Agreement
1	Hoyle resonance [16]: $7.6549/28.3 = 0.2706$	$6(\pi - 3)/\pi = 0.2704$	0.07%

#	Experiment / observation	ODTOE prediction	Agreement
2	Kozyrev effects: $\Delta R/R \sim 10^{-5}$–10^{-6}	Gap power $\sim 0.1\ \mu$W at $\eta S \sim 10^{-12}$	Order
3	Baryon asymmetry: $\eta \sim 10^{-10}$	$\eta \propto (\pi-3)^n$ (small, power-law)	Qualitative
4	Width of resonances in nuclear cross-sections	$\Gamma/E \sim (\pi-3)^2 \approx 2\%$	Testable (F1, F2 [5])
5	DNA double helix pitch: 0.34 nm / 10 bp	$2(\pi-3) = 0.283$; $\pi/10 = 0.314$	Order

Direct confirmation of $(\pi-3)^2$ as an exact number has *not been obtained*. All five are *indirect*, of the correct order. To move from indirect to direct confirmations, experiments from works [5, 7] are needed, whose predictions are expressed in units of $(\pi-3)^2$ up to a factor of order unity.

IV.4. What is born in the gap

The gap is not a "loss". The gap is the *source of everything*:

Each revolution of the loop does not close $\to \delta\Psi \neq 0$ is born $\to$ a directed increment. This increment is *time* (the next tick), *energy* (a quantum of action), *development* (a new turn of the spiral).

If the loop closed exactly ($\pi = 3$): no gap $\to$ no increment $\to$ no time $\to$ no next turn $\to$ reality would have ended on the first revolution.

$(\pi-3)^2$ is the *breath of reality*. Inexhaustibility. The source of time, energy and development. The transcendence of π [11] guarantees that the gap $\pi-3$ can never vanish: under no rational operations can π become an integer. Reality *cannot* stop.

V. THE TERNARY STRUCTURE OF π: $3 \to 6 \to 9$

V.1. Three octaves of the number π

$$1 \times \pi \approx 3: \quad \text{the act of observation (the minimal triad)} \tag{V.1}$$

$$2 \times \pi \approx 6: \quad \text{the full cycle (forward + reverse)} \tag{V.2}$$

$$3 \times \pi \approx 9: \quad \text{self-observation (a cycle observing itself)} \tag{V.3}$$

These three "octaves" are not a coincidence but a *consequence* of the ternary architecture. The number π carries within itself a "memory" of three: $\pi \approx 3$ because the minimal closed path (a circle) is inscribed in the minimal polygon (a triangle). The ratio of the perimeter of an inscribed regular n-gon to the diameter tends to π from below, and at $n = 3$ gives $3\sqrt{3}/2 \approx 2.598$, while π itself lies between $n = 3$ (lower bound) and $n = \infty$ (upper).

V.2. Decoding

$1 \times \pi \approx 3$**: the act.** Three components: observer O, observed R, operator $\hat{O}$. The minimal structure without which observation is impossible. One direction: $\mathcal{H} \to \mathcal{C}$. Examples of ternarity: the quark triplet in a nucleon, Tesla's three-phase current, the three spatial dimensions, the Trinity in theology. In all cases the triad is the minimal *closed* structure: two elements give a line, three give a cycle.

$2 \times \pi \approx 6$**: the cycle.** Three components $\times$ two directions (forward $\hat{O} : \mathcal{H} \to \mathcal{C}$ and reverse $\iota : \mathcal{C} \to \mathcal{H}$). There and back. Inhalation and exhalation. Carbon ($Z = 6$) — the basis of life: 6 protons + 6 neutrons + 6 electrons = a full cycle at each of three levels. In the formula $\mu = 6\pi^5$ [4]: the factor 6. Six is the number of cycle completeness; it is no coincidence that the crystal lattice of graphene (carbon) is hexagonal.

$3 \times \pi \approx 9$**: self-observation.** A cycle observing itself. $9 = 3 \times 3$. The fixed point: $\Psi^* = \Phi(\Psi^*)$. The digital root of any multiple of 9 is 9 (nine always returns to itself). The numerical image of self-consistency. Nine is the archetype of a cycle closing upon itself: in decimal arithmetic 9 is the last single-digit number, after which the "second revolution" begins (10, 11, ...). In music the ninth harmonic closes the natural harmonic series.

V.3. Tesla and ODTOE

N. Tesla: "If you knew the magnificence of 3, 6 and 9, you would have a key to the Universe" [12].

ODTOE: 3 is observation. 6 is the cycle. 9 is consciousness. The key is not a metaphor but *architecture*. Tesla, who worked with three-phase alternating current [24], intuitively grasped the ternary structure underlying electromagnetism. ODTOE formalises this intuition: the triad of components $(O, R, \hat{O})$ generates the triad of levels $(3, 6, 9)$, each responsible for its own aspect of reality.

V.4. The "approximations" ($\approx$) are not a defect

$1 \times \pi = 3.14159\ldots \neq 3$. The difference $(\pi - 3) = 0.14159$ is the spiral gap. "Almost three, but not three" is the source of development.

$2 \times \pi = 6.28318\ldots \neq 6$. The difference $2(\pi - 3) = 0.28318$ is the double gap (two directions).

$3 \times \pi = 9.42478\ldots \neq 9$. The difference $3(\pi - 3) = 0.42478$ is the triple gap (self-observation generates the maximum gap).

Each level generates *its own* gap, proportional to the level number. Self-observation ($3 \times \pi$) generates a gap three times larger than a simple act ($1 \times \pi$). More awareness $\to$ more gap energy $\to$ more development. This regularity can be formalised:

$$\delta_k = k(\pi - 3), \quad E_k = k^2(\pi - 3)^2, \quad k = 1, 2, 3. \tag{V.4}$$

The energy grows as the square of the level — analogously to energy quantisation in an infinite potential well ($E_n \propto n^2$).

VI. THE NUMBER 137: DERIVATION FROM FIRST PRINCIPLES

VI.1. The problem

The fine-structure constant $\alpha = e^2/(\hbar c) \approx 1/137.036$ is a dimensionless number determining the strength of the electromagnetic interaction [8]. R. Feynman: "All good theoretical physicists put this number up on their wall and worry about it" [18]. Nobody has derived it from first principles. P. Dirac [22] supposed that α might be connected with cosmological parameters. A. Eddington [25] constructed an (unsuccessful) theory in which $\alpha^{-1} = 136$ (later corrected to 137). Both attempts demonstrated the *scale of the problem*: the number 137 is not derived from the Standard Model but inserted from experiment.

VI.2. The base formula

$$\alpha_0^{-1} = 4\pi^3 + \pi^2 + \pi = \pi(4\pi^2 + \pi + 1) = 137.03630 \tag{VI.1}$$

Six correct significant digits from pure π [4].

$4\pi^3$ is the action of $\hat{O}$ through the four coherence components B ($F, E, (1-\sigma), \Lambda$), each on the ternary architecture (π^3). The four components of B are four aspects of the observer's connection with reality: focus (F), energy (E), stability ($1-\sigma$) and horizon (Λ) [1].

π^2 is the cost of the return ι through two "gates" (de-actualisation + re-potentialisation). The operator ι transfers the configuration R back into the field $\mathcal{H}$, passing through two stages: the dissolution of the concrete form and the restoration of potentiality.

π is the topological cost of the observer's presence in the loop. The observer is not an external "spectator" but a participant in the loop, whose presence adds one factor of π to the total cost of interaction.

VI.3. Self-referential correction (nine digits)

$$x^2 - \pi(4\pi^2 + \pi + 1) \cdot x + 2(\pi - 3)^2 + (\pi - 3)^4\varphi = 0, \quad x = \alpha^{-1} \approx 137.035999 \tag{VI.2}$$

Nine correct significant digits. Zero free parameters. The detailed derivation is in [4].

Equation (VI.2) is *quadratic*: it has two roots. The physical root $\alpha^{-1} \approx 137.036$ is the larger one. The second root $x_2 \approx 2.92 \times 10^{-4}$ is small, interpretable as the "interaction cost" at the scale of the spiral gap. Self-reference manifests in the fact that the free term contains $(\pi - 3)^2$ and $(\pi - 3)^4\varphi$ — precisely the spiral corrections that α itself determines in electromagnetic processes.

VI.4. Rough approximation $\alpha \approx \varphi^2/360$

$\varphi^2/360 = 2.618\ldots/360 = 1/137.508$ (accuracy 99.7%). This is a *compression* of the exact formula: the contributions $4\pi^3 + \pi^2 + \pi$ are "compacted" into a single ratio. Formula (VI.2) *unpacks* the compression.

The substantive meaning of $\varphi^2/360$: the square of the golden ratio (the area of one "iteration step"), divided by the number of distinguishable states of the full cycle ($360° = 6 \times 60 = 6 \times 3 \times 4 \times 5$). A measure of the *coupling* of the discrete (φ) and continuous (2π) aspects of the loop. Sherbon [26] independently noted the connection of α with φ through golden-ratio geometry, without however proposing a self-referential formula.

VI.5. The number 137 and prime numbers: where structure ends and numerology begins

137 is the 33rd prime number. $33 = 3 \times 11$.

Structural connection (not numerology):

$3 =$ the minimal ternary architecture of ODTOE. The number of loop components. The number of spatial dimensions. Justified axiomatically [1, Axiom A].

$11 =$ the number of dimensions of M-theory [9]. Through ODTOE: $11 = 9 + 2$ (self-observation + two directions of the operator) $= 3 + 4 + 4$ (space + B of the observer + B of the meta-observer) $= 5 + 6$ (arguments of π + full cycle). Three independent decompositions [10].

$3 \times 11 = 33$: the ternary architecture "projected" through all 11 dimensions. $\alpha^{-1} = 137 =$ the 33rd prime $=$ the number that "occupies the 33rd position" in the sequence of irreducibles.

The boundary of numerology:

The connection "$137 =$ 33rd prime" is an *observation*, not a *derivation*. It does not follow from ODTOE that α^{-1} *must* be prime. Formula (VI.2) yields $\alpha^{-1} = 137.035999\ldots$ — not an integer, not prime. The integer 137 is an approximation. The connection with the 33rd prime is a coincidence requiring caution.

Demarcation:

Statement	Status
$\alpha^{-1} = \pi(4\pi^2 + \pi + 1) -$ corrections (9 digits)	Numerical coincidence + interpretation
$3 =$ ternary architecture	Follows from Axiom (A)
$11 =$ dimensionality of M-theory	Follows from [9], decoded through ODTOE [10]
$3 \times 11 = 33$: "projection of the triad through 11 dimensions"	Hypothesis
$137 =$ 33rd prime	Observation (**numerology**, not justified)

VII. PLANCK'S CONSTANT: ABSOLUTE OR RELATIVE?

VII.1. The standard position

$h = 6.62607015 \times 10^{-34}$ J s is a fundamental constant. Since 2019 it is a *defining* (not measured) constant, entering the definition of the kilogram [8]. Status: absolute, immutable, the same everywhere. The SI system was revised in 2019 so that h is fixed as an exact number from which the unit of mass is *derived*. This means that the question "what is the value of h?" has become a tautology — h is what we decided to call h.

VII.2. The ODTOE question

2π is an absolute constant (a topological invariant: the circumference at unit radius, independent of anything).

h is the minimum portion of action. But *whose* action? That of an observer with dimensionality d and coherence S. The question: is the "grain of observation" the same for a quark ($d = -1$) and for a galaxy ($d = 7$)?

Analogy: the speed of sound "seems a constant" if one spends one's entire life in a single medium. 343 m/s in air at 20 °C. But in water it is 1480 m/s. In steel it is 5960 m/s. The "constant" turned out to be a property of the medium. An analogous situation is possible with h: all measurements have been performed in a single "medium" ($d = 3$, $S \approx$ const).

VII.3. Hypothesis: $h = h(d, S)$

All measurements of h have been carried out by observers with $d = 3$, at the S of our cluster. We obtain *one* number. But this may be:

(a) A fundamental constant (the same at all levels).

(b) An effective parameter (dependent on d and S).

By Ashby [1, Proposition 3]: we cannot observe the "grain of observation" of a level that is inaccessible to us. To measure h for $d = 7$ is impossible — one would need to be an observer of $d = 7$. This is not a technical but a *fundamental* limitation: D-Prot (Dimensional Protocol) forbids direct access to the observation parameters of other dimensionalities [1].

VII.4. Predictions and ways of testing

If $h = h(d, S)$, then:

(a) h may depend on scale. Prediction: when measured at *different* scales (atomic vs. macroscopic) h may *slightly* differ. Current precision: $\delta h/h \sim 10^{-8}$. If the dependence on d is of order $(\pi - 3)^4 \sim 4 \times 10^{-4}$, it has not yet been detected. But if of order $(\pi - 3)^8 \sim 10^{-7}$ — it is at the limit of current sensitivity.

Experiment: compare h measured via the Josephson effect (scale $\sim 10^{-9}$ m, $d \approx 0$) and via the Kibble balance (scale $\sim 10^{-1}$ m, $d \approx 2$). If there is a discrepancy $> 10^{-8}$ — evidence for the dependence of h on d.

(b) h may depend on the coherence of the medium. Prediction: h measured in a *superconducting* loop ($S \to 1$) may *slightly* differ from h in a normal conductor ($S \ll 1$). The Josephson effect *in a superconductor* gives h with one precision; measurement via

the photoelectric effect *in an ordinary metal* gives another. The discrepancy $= \delta h \propto (1 - S)^n$ for some n.

(c) "Planck's constant" for other dimensionalities. For an observer with $d < 3$: $h_{d<3}$ may be *larger* (coarser grain, lower resolution). For $d > 3$: $h_{d>3}$ may be *smaller* (finer grain, higher resolution). An observer of $d = 7$ (a galaxy) "sees" with a resolution inaccessible to us — its h may be orders of magnitude smaller than ours.

Direct verification is impossible (D-Prot). Indirect: if h depends on d, this must manifest as *inconsistency* in measurements of h at different scales. Current data: consistency to 10^{-8}. This either means $h =$ const, or that the dependence is weaker than 10^{-8}.

VII.5. An honest answer

Statement	Status
2π is an absolute constant	**Yes** (topological invariant)
h is an absolute constant	**Unknown** (all measurements at $d = 3$, $S \approx$ const)
$h = h(d, S)$	**Hypothesis** (not contradicted by data, not confirmed)
Is it testable?	Yes: Josephson vs. Kibble, superconductor vs. normal metal

VIII. THE CONNECTION OF $(\pi - 3)^2$, φ AND DIMENSIONALITY d

VIII.1. Three aspects of a single spiral

$$(\pi - 3)^2 = \text{the energy grain per turn (what)} \tag{VIII.1}$$

$$\varphi = \text{the proportion between turns (how)} \tag{VIII.2}$$

$$d = \text{the observer's horizon (where)} \tag{VIII.3}$$

The three aspects are not independent: they are connected through formula (VIII.4). "What" determines the minimum portion of energy available on each turn. "How" determines the scale transition between turns. "Where" determines how many turns the observer sees. Together they define the *complete energy picture* of the observation spiral.

VIII.2. Formula for the energy accessible to the observer

$$E_{\text{total}}(d) = \sum_{n=-d}^{d} (\pi - 3)^{2|n|} \cdot \varphi^{2|n|-1} \tag{VIII.4}$$

The sum is *finite* (d is finite). As $d \to \infty$: it tends to $(\pi-3)^2\varphi/(1-(\pi-3)^2\varphi^2)$ — the series from the formula for μ [4]. Each term of the sum (VIII.4) corresponds to one level of recursion: $n = 0$ is the level of the observer itself, $n > 0$ are the "inner" levels (subatomic), $n < 0$ are the "outer" ones (cosmological). The summation over $|n|$ reflects the symmetry of the spiral: the observer "looks" both inward and outward.

VIII.3. The dimensionality of space is the operator's horizon

Dimensionality is not a property of "the world in itself" but a characteristic of the observer [10]. $d(O)$ is the number of recursive layers accessible to the operator $\hat{O}$. The observer sees as many dimensions as d permits. The three dimensions of space are not a "given" but $d(\text{human}) = 3$: the minimum for $\hat{O}(\hat{O})$ (consciousness).

The fourth "dimension" (time) is iterative: the sequence of revolutions Φ^n. Not a spatial axis but a *turn counter* of the spiral. Time does not "flow" — it *counts*: each tick n is one revolution of the loop, one quantum of action, one observation event.

VIII.4. The 11 dimensions of M-theory

$11 = 9 + 2 = 3 + 4 + 4 = 5 + 6$. Three independent decompositions [10]:

$9 + 2$: full self-observation (the first octave) + two directions of the operator ($\hat{O}$ and ι).

$3 + 4 + 4$: three spatial + four components of B of the observer + four components of B of the meta-observer.

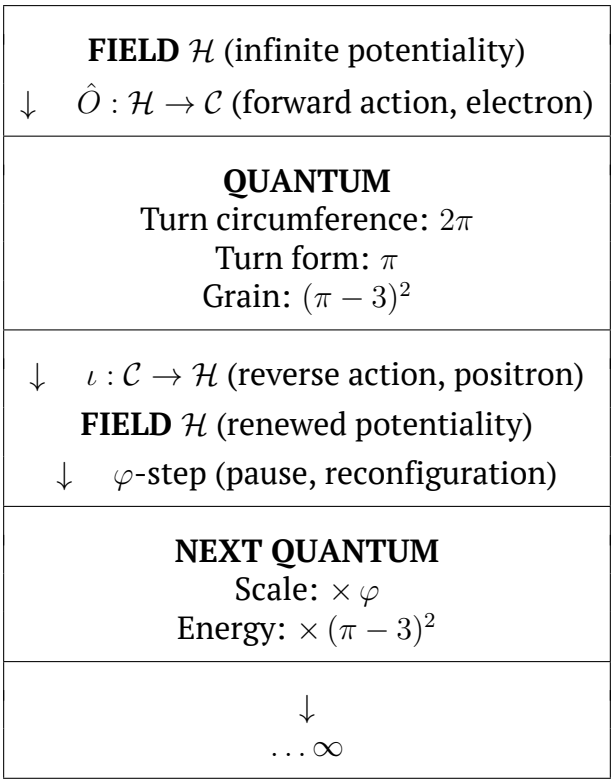
$5 + 6$: five arguments of π + full cycle ($= 6\pi^5$ from the formula for μ [4]).

We exist in all 11. We see 3. We feel 4–8 indirectly. We compute 9–11 through mathematics.

Witten [9] showed that 11-dimensional supergravity is the low-energy limit of M-theory. ODTOE does not derive the number 11 "from nothing" — it *interprets* it through the ternary architecture, offering a substantive justification for what in string theory is postulated.

IX. THE UNIFIED PICTURE

IX.1. Everything in one diagram



The diagram illustrates the central thesis of the paper: a quantum is not a "tiny particle" but *one cycle* of the map Φ. The forward action $\hat{O}$ converts potentiality into actuality (an analogue of the electron as the instrument of observation). The reverse action ι returns the configuration to the field $\mathcal{H}$ (an analogue of the positron as "anti-observation"). Between turns there is a φ-step: a discrete rescaling. The infinity $\ldots \infty$ at the bottom of the diagram is not spatial infinity but the infinity of iterations: reality does not stop because $\pi \neq 3$.

IX.2. Four numbers — all of reality

Number	Role	What it determines	Type
π	Turn form	Continuous dynamics (rotation, wave)	Transcendental
φ	Spiral pitch	Discrete dynamics (iteration, recursion)	Irrational
$(\pi - 3)^2$	Energy grain	What is born in each turn	Derived from π
d	Horizon	How many turns the observer sees	Integer

IX.3. Connections between them

π and φ arise from a *single* mechanism (the Banach theorem [2]): continuous and discrete convergence to Ψ^*.

$(\pi-3)^2$ is derived from π: the cost of $\pi \neq 3$ (three is the skeleton, but not the point).

d determines *how many* turns of the spiral (levels of recursion) are accessible to the observer.

$h = (\pi-3)^2 \times \varphi \times f(d, S)$ — hypothesis: Planck's constant = grain × step × function of dimensionality and coherence.

$\alpha^{-1} = \pi(4\pi^2+\pi+1)-$corrections — the cost of electromagnetic coupling expressed through loop components.

$\mu = 6\pi^5 +$ series — the proton mass as fivefold self-consistency of the full cycle [4].

All six formulae contain only π, φ, integers and (in the case of h) a function $f(d, S)$ to be determined. There are no fitting parameters. Every factor has a substantive interpretation in the ODTOE formalism.

IX.4. Final formulation

Quantum $= 2\pi$ (revolution). Pause $= \varphi$ (step). Grain $= (\pi-3)^2$ (gap). Horizon $= d$ (dimensio

(IX.1)

Four numbers. One spiral. All of physics.

A quantum is not a "tiny portion". A quantum is one inhalation-exhalation of the Universe. 2π is the length of the inhalation-exhalation. φ is the rhythm of breathing. $(\pi-3)^2$ is the novelty born in each breath. d is the depth of the lungs.

X. DEMARCATION

Each statement in the present work has a definite epistemic status — from experimental fact to unjustified observation. The table below records this status.

Statement	Status
Quantum = one revolution of Φ of length 2π	Interpretation through ODTOE, consistent with $\hbar = h/(2\pi)$
Pause between quanta = φ-step	Follows from the Banach theorem (discrete convergence)
Resonance ratio = φ ($CoNb_2O_6$)	**Experimental fact** [3]
Spiral = φ-nested circles	Follows from logarithmic spiral + transcendence of π
$(\pi-3)^2$ = gap energy	Follows from ternary architecture + quadratic law

Statement	Status
5 indirect confirmations of $(\pi-3)^2$	Order-of-magnitude coincidences, not direct measurements
$\alpha^{-1}=\pi(4\pi^2+\pi+1)-\ldots$ (9 digits)	Numerical coincidence + interpretation
137 = 33rd prime, $33=3\times11$	Observation (**numerology**, not justified)
α^{-1} from (VI.2) (9 digits)	**Justified** through ODTOE [4]
$h=h(d,S)$	**Hypothesis**, testable: Josephson vs. Kibble
$1\pi\approx3$, $2\pi\approx6$, $3\pi\approx9$	Follows from $\pi\approx3$ + ternary architecture
11 dimensions $=9+2=3+4+4=5+6$	Substantive interpretations [10]

DISCUSSION AND LIMITATIONS

The present work proposes a unified architecture of the quantum built on four numbers (π, φ, $(\pi-3)^2$, d). Limitations of the construction:

1. *Numerical coincidences.* Formulae (VI.1) and (VI.2), yielding 6 and 9 correct significant digits for α^{-1}, remain *numerical coincidences* until the interpretation of each factor is independently confirmed. An analogous problem faces any attempt to derive fundamental constants [27].

2. *Dependence of h on d and S.* The hypothesis $h=h(d,S)$ (Section VII) has not been confirmed experimentally. The current consistency of measurements of h at the level of 10^{-8} places an upper bound on the possible dependence but does not exclude it.

3. *Indirectness of confirmations.* All five experimental confirmations of the spiral gap $(\pi-3)^2$ (Section IV.3) are indirect, order-of-magnitude. For direct confirmation, experiments specifically designed to measure quantities of order 2% are needed.

4. *Numerology.* The connection of the number 137 with the 33rd prime (Section VI.5) remains an observation without theoretical justification. The author deliberately labels it "numerology" and does not accord it evidentiary status.

5. *Falsifiability.* The construction is falsifiable: detection of a dependence of h on scale ($\delta h/h>10^{-8}$) would confirm hypothesis VII.3; its absence at a precision of 10^{-12} would weaken it. Likewise, measurement of the width of nuclear resonances $\Gamma/E\neq(\pi-3)^2$ to a precision of 0.1% would falsify prediction IV.3.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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