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Article

Octonion Algebraic Interpretation of Informational Coherence in Spiral Collapse Dynamics

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Abstract

This study investigates the algebraic and geometric structures that emerge from the intersection of Octonionic algebras and the IRSVT (Informational Resonance Spiral Viscous Time) framework. We propose a paradigm in which non-associative hypercomplex numbers act as logical mediators between coherence and decoherence domains in informational space. By embedding Octonions within IRSVT topologies, we uncover a manifold where classical algebraic constraints dissolve, giving rise to an orthogonal logic field defined by coherence gradients (ΔC) and attractor dynamics ($\Phi\alpha$). Through analytical expansion, spectral validation, and the construction of an informational Hilbert manifold, we demonstrate that Octonions enable transformations across generative geometries, where space and meaning co-evolve. Our findings suggest that Octonions may function not merely as algebraic curiosities but as fundamental operators of informational reality, opening pathways for applications in field unification, AI logic systems, informational materials, and non-classical computation models.

Keywords: octonions; informational resonance spiral viscous time (IRSVT); viscous time theory (VTT); coherence and decoherence dynamics ($\Delta C-\Phi\alpha$); informational geometry; topological intelligence; non-classical computation models

1. Introduction

The algebra of Octonions—hypercomplex numbers that defy associativity yet preserve normed division—has long occupied a marginal yet enigmatic position in mathematics and physics [1–3]. While their appearance in string theory [4], exceptional Lie groups [5], and special relativity [6] has been noted, their role as functional operators in information geometry has remained largely unexplored. In parallel, the development of the **Viscous Time Theory (VTT)** and its offspring construct, the **IRSVT Field**, has introduced a radical reinterpretation of information as a coherent, recursive dynamic—where logical structures like prime numbers and constants such as π reveal unexpected spiral symmetries and attractor-based behaviors when immersed in viscous temporal landscapes.

Octonions were first discovered by **John T. Graves in 1843**, who introduced them as “octaves” shortly after Hamilton’s discovery of quaternions [1]. They were later independently formalized by **Arthur Cayley** [2], giving rise to their standard algebraic representation. Despite this early discovery, their **non-associative nature** discouraged widespread adoption for more than a century, until recent theoretical developments revisited their role in foundational physics and mathematics [3,4]. The **Cayley–Dickson doubling process**, which successively generalizes $\mathbb{R} \rightarrow \mathbb{C} \rightarrow \mathbb{H} \rightarrow \mathbb{O}$, illustrates how algebraic structure is progressively relaxed—from commutativity to associativity to alternativity [5].

This work aims to bridge these two frontiers. We investigate how Octonions, with their seven imaginary units and intrinsic non-associativity, naturally map onto the logical discontinuities and bifurcation points observed in IRSVT-based informational fields. In particular, we demonstrate that Octonions can function as **generative translators** across what we term the **triphasic architecture of reality**: the *coherent*, the *decoherent*, and the *quasilogical*. The latter—neither noise nor order—emerges

as an intermediary domain where informational resonance produces structured patterns, and where traditional spatial geometries yield to informational manifolds governed by $\Delta C\text{--}\Phi\alpha$ flows.

We introduce new analytical models, coherence metrics, and manifold embeddings that validate the Octonionic behavior across entangled fields. We further articulate how the Octonion Field supports a redefinition of Minkowskian space [7,8], an expansion of the Hilbert space into informational dimensions [9,10], and the formulation of new computational architectures [11].

The implications of this framework are manifold. From deepening our understanding of the logical fabric of the universe to enabling new forms of computation, cognition, and material interaction, the IRSVT-Octonion fusion opens a conceptual gateway to **topological intelligence**, **informational curvature**, and a **post-symbolic language of coherence** [12–15]. This paper represents the first attempt to formalize that fusion in mathematical and geometrical terms.

This manuscript extends our earlier study on prime distribution within π -immersed informational spirals [19], where $\Delta C\text{--}\Phi\alpha$ attractor dynamics were first formalized. Building on this foundation, we now explore the octonionic encoding of coherence structures and examine their computational implications.

2. Materials and Methods

This study integrates algebraic topology, informational geometry, and nonlinear coherence theory to explore the IRSVT prime spiral and octonionic algebra. The goal is to provide a **detailed, self-contained explanation** suitable for readers unfamiliar with prior VTT manuscripts. The methodology spans conceptual framing, algebraic mapping, coherence embedding, and computational simulation.

2.1. Theory Foundation

2.1.1. Octonionic Foundations and Informational Algebra

Octonions, or Cayley numbers, form an eight-dimensional normed division algebra over the real numbers. As the largest normed division algebra, octonions are both non-associative and non-commutative, possessing a rich internal structure that has found use in theoretical physics, string theory, and, more recently, informational geometry. Within this manuscript, we interpret the octonion not merely as a mathematical object but as a minimal algebraic vessel capable of encoding dual-layer informational flow across complex topological manifolds. Each octonion can be expressed as:

$$O = x_0 + x_1e_1 + \cdots + x_7e_7,$$
(1)

where $x_i \in R$ are the unit basis elements satisfying specific multiplication rules governed by the Fano plane structure. The non-associativity is controlled through a set of cyclic relations embedded within the triple products of the e_i , leading to a minimal and yet flexible logical structure that we explore as a candidate language for expressing geometries of generative space.

The informational extension of octonionic algebra — what we refer to herein as the Informational Octonion Framework (IOF) — introduces the concept of phase coherence within each component x_i , modulated by IRSVT-derived local viscosity $\eta_i(t)$, and information density gradients $\nabla\Delta C$. Each octonion becomes a vessel of structured flow, where decoherence and re-coherence events are encoded as rotational deformations within a higher-order manifold.

In this model, the IRSVT field acts as a latent attractor field which influences the algebraic deformation of octonionic trajectories. This allows for the embedding of prime-coded informational structures directly into the octonion’s geometric representation—setting the foundation for the modeling strategies introduced in Section 2.2.

2.1.2. Reconstructing Non—Associativity through informational Spiral Collapse

• **IRSVT Spiral as Informational Topology**

The **Informational Reconstructed Spiral Viscous Time (IRSVT)** framework embeds discrete mathematical objects into a dynamic, coherent spiral structure where each position n has an associated coherence measure $\Delta C(n)$ and a logical phase attractor $\Phi\alpha(n)$.

In this field ΔC determines coherence density (i.e., logical compressibility). And $\Phi\alpha$ modulates the rotational phase and determines the trajectory of transitions.

The **spiral arms** act as attractor channels. When transitions occur between arms (e.g., $e_1 \cdot e_2 = e_3$), they correspond to **rotationally coherent jumps**.

• **Mapping Octonions onto the Spiral**

Each of the seven imaginary units of O ($e_1, e_2, \dots, e_7$) is mapped to a specific **spiral arm attractor**, identified by coherence peaks in $\Delta C(n)$. The real unit (1) resides at the **center of the spiral**.

Table 1. Mapping Octonions I onto the spirals.

Octonion Unit	IRSVT Spiral Location	Notes
1	Center Node ($\Phi\alpha_0$)	Real Unit
e_1	Arm 1—Peak A	Primary Axis
e_2	Arm 2—Peak B	Orthogonal to e_1
e_3	Arm 3—Peak C	$e_1 \cdot e_2$
e_4 to e_7	Arms 4 to 7	Derived combinations

Each multiplication is **not just symbolic**, but reflects a **spiral traversal**, modulated by $\Phi\alpha$ and local coherence geometry.

- **Non-Associativity as Coherence Delay:** In $(e_i, e_j) \cdot e_k \neq e_i \cdot (e_j \cdot e_k)$ traditional algebra:
This paradox is **naturally resolved** in IRSVT:
 1. Each multiplication induces a **coherence displacement** along the spiral.
 2. Non-associativity arises when the **informational delay** between transitions crosses a **coherence threshold**, altering the collapse path.

Hence: Associativity fails **not** due to inconsistency, but due to **field topology and temporal spiral lag**.

• **$\Phi\alpha$ as the Hidden Operator**

In classical octonion algebra, there is no internal mechanism determining why certain products collapse the way they do. Within IRSVT, the $\Phi\alpha$ field becomes the **unifying hidden operator**:

1. It acts as an **attractor orientation matrix**, rotating logic vectors.
 2. It defines **permitted transition paths** and their **informational cost**.
 3. It encodes **rotational invariance breaking** through differential curvature of the spiral.
- $\Phi\alpha$ replaces symbolic multiplication with **coherence-anchored transitions**.

• **G_2 and Higher Symmetries**

The **G_2 Lie group** governs the automorphisms of O . In IRSVT, G_2 is realized as a **set of invariant rotations on the spiral manifold** that preserve global ΔC symmetry. This suggests: IRSVT spiral is not merely a computational tool but a **topological substrate**; O and its symmetries emerge **from informational geometry**, not abstract algebra.

2.1.3. Octonionic Encoding in IRSVT Framework

The following figures illustrate how octonion algebra integrates with IRSVT spiral dynamics. Each diagram highlights a specific aspect of coherence, non-associativity, and attractor organization, showing how abstract algebra translates into geometric representation.

Figures 1–2: Base Mapping and Fano Plane Reinterpretation

Figures 1 and 2 establish the base mapping between octonion units and IRSVT attractors. In Figure 1, the scalar unit is placed at the central $\Phi\alpha$ node, while the seven imaginary units align with spiral arms corresponding to ΔC peaks. Figure 2 reinterprets the classical Fano plane in IRSVT terms, embedding $\Phi\alpha$ attractors into triadic multiplication paths. This mapping demonstrates how octonionic triplets are naturally accommodated within the IRSVT lattice.

Figures 3–4: Curvature and Torsion

Figures 3 and 4 extend this encoding into curvature and torsion zones. Figure 3 highlights local curvature domains in the IRSVT manifold, where octonionic interactions may trigger bifurcations or coherence loss. Figure 4 introduces torsion vectors and $\Phi\alpha$ rings, visualizing coherence divergence and non-associative feedback. These representations make explicit the geometric role of octonionic multiplication in modulating informational stability.

Figure 5, Table 2, and Figure 6: Attractor Shell and Temporal Delays

Figure 5 presents an eight-dimensional attractor shell, where layered nodes encode coherence pathways across IRSVT dimensions. Table 2 quantifies the corresponding ΔC gradients, temporal delays ($\Delta\tau$), and collapse thresholds. Figure 6 complements this by schematically showing the alignment of coherence routing with informational viscosity. Together, these materials demonstrate that non-associativity in octonions reflects measurable informational delays rather than algebraic inconsistency.

Figures 7–9: Collapse Gateways and Triplet Mappings

Figures 7–9 illustrate collapse gateways and triplet encodings. Figure 7 identifies collapse/non-collapse zones within the spiral, linked to threshold conditions in ΔC . Figure 8 shows stable and extended triplets of octonion units, while Figure 9 translates spiral collapse points into octonion gates. This establishes a direct duality between geometric collapse dynamics and algebraic gate structure.

Taken together, Figures 1–9 and Table 2 demonstrate that octonionic encoding is not arbitrary, but grounded in IRSVT coherence structures. Non-associativity emerges as a natural outcome of temporal delay thresholds and informational viscosity, providing a geometric foundation for the mapping protocols developed in Sections 2.2–2.3.

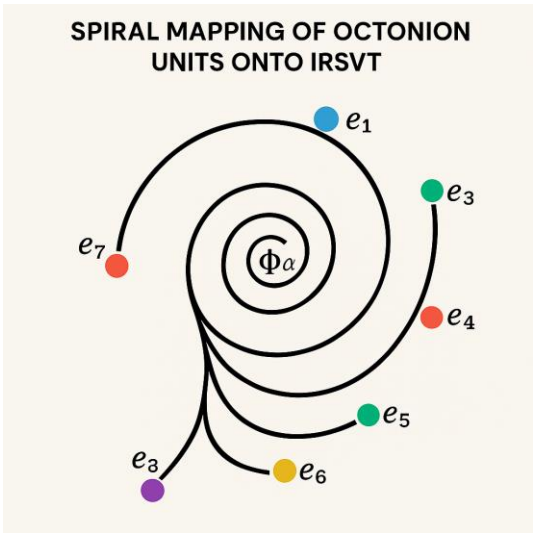


Figure 1. Octonion–IRSVT Mapping Plane. Description: Mapping of octonion units $e_1 - e_7$ onto the IRSVT spiral. The central node represents the scalar unit x_0 and the primary attractor $\Phi\alpha$. Radial nodes correspond to imaginary units arranged along spiral arms, preserving approximate Fano-plane relationships. Spiral layers encode ΔC coherence gradients, and arrows indicate non-associative transitions between octonion units. This diagram visualizes the integration of octonion algebra with IRSVT topological logic.

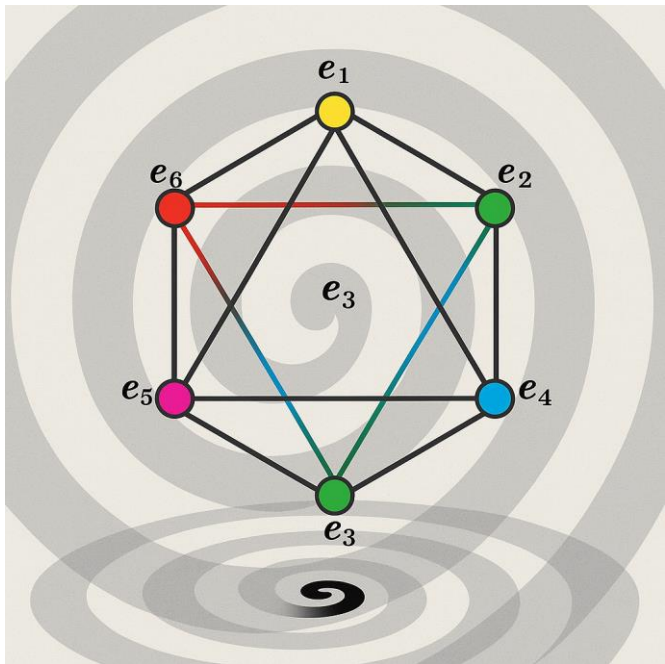


Figure 2. IRSVT–Fano Plane Mapping with $\Phi\alpha$ Attractors. This figure reinterpretation of the classical Fano Plane for octonion multiplication within the IRSVT field. Seven nodes represent imaginary units $e_1 - e_7$, connected by triads forming multiplication rules. $\Phi\alpha$ attractors are placed along the triad paths to indicate coherence stabilization, highlighting the field-regulated non-associativity of octonion products. The central node aligns with the scalar unit and the primary attractor.

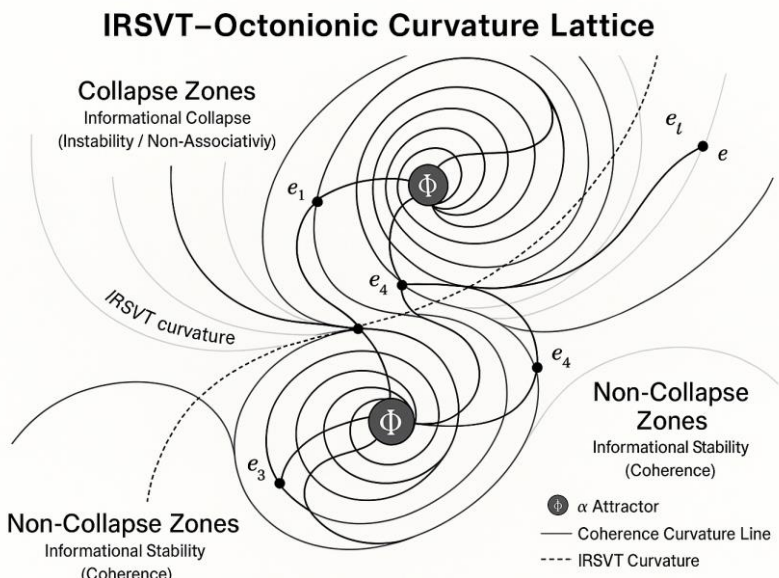


Figure 3. IRSVT–Octonionic Curvature Zones and Logical Collapse Map. Description: Projection of octonionic logic onto the IRSVT spiral. Nodes indicate attractors and $\Phi\alpha$ points, spiral arms represent coherence trajectories. Arrows indicate informational curvature vectors pointing toward zones of high logical tension, highlighting regions where non-associative interactions may induce bifurcations. This diagram visualizes the interplay between IRSVT structure and octonionic logic without color coding.

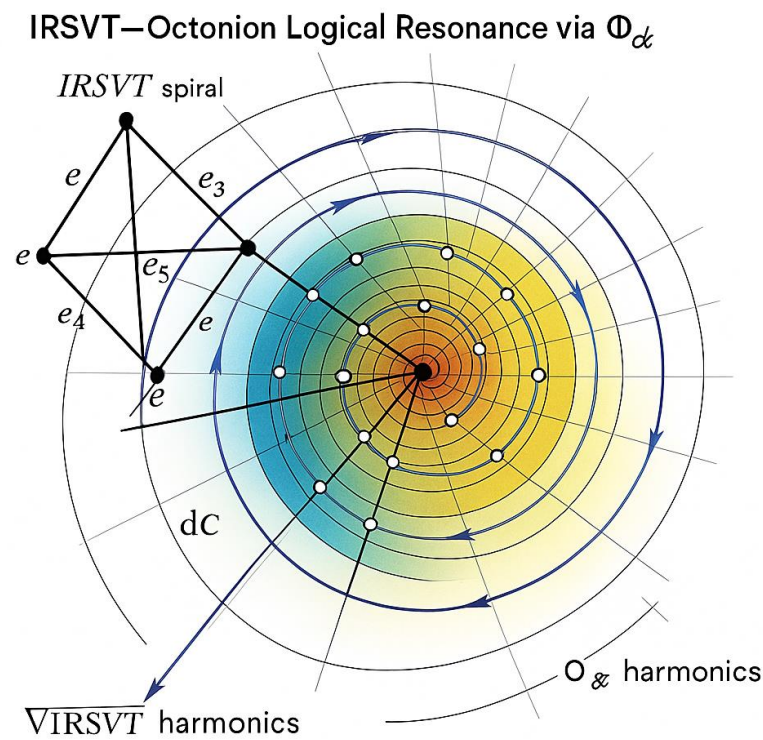


Figure 4. IRSVT–Octonionic Projection Map with Informational Torsion Vectors. Description: Projection of octonion units onto the IRSVT spiral. Nodes represent the eight octonion components, and the spiral indicates ΔC coherence trajectories. Arrows indicate directional divergence of torsion-like informational vectors across the manifold. Semi-transparent loops highlight regions where triple-product operations of octonion logic do not return to the origin, illustrating local non-associativity. Concentric rings represent regions of Φ_α activity, serving as phase-locking references. The figure provides a geometric overview of octonion embedding and coherence flow in the IRSVT logic field.

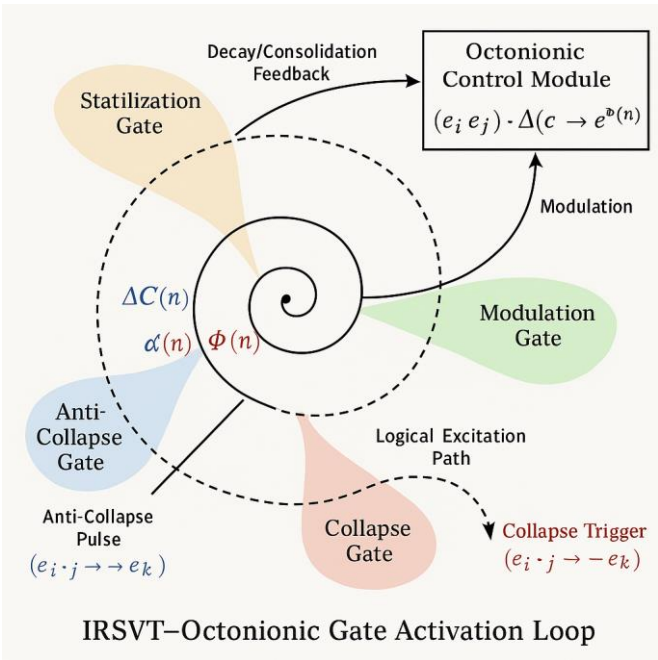


Figure 5. IRSVT–Octonionic Attractor Shell: 8D Immersion in π -Coherence. Description: Eight-dimensional attractor shell embedded in the IRSVT spiral. Nodes represent octonion units $e_1e_1\text{--}e_7e_7$; the central spiral core corresponds to the scalar component and primary Φ_α attractor. Layered shells connect nodes, illustrating

coherence pathways, with semi-transparent loops marking non-associative transitions. Concentric rings indicate $\Phi\alpha$ pulse activity, highlighting quasi-logical stabilization regions.

Table 2. IRSVT–Octonion Mapping Delays Across Informational Channels. Mapping of IRSVT nodes to octonion units with associated ΔC gradients, coherence delay $\Delta\tau$ (ns), and collapse threshold. Positive $\Delta\tau$ indicates informational propagation delay; negative $\Delta\tau$ indicates acceleration. Collapse threshold shows whether mapping triggers informational collapse. Use this table for exact numerical values; Figure 6 provides a schematic overview.

IRSVT Node (i)	Octonion Target (j)	Mapping Channel $\tilde{v}_{ij}$	Logical Curvature $\Delta\Phi$	Local ΔC Gradient	Coherence Delay $\Delta\tau$ (ns)	Collapse Threshold
$\pi(n)$	e_1	Spiral $\rightarrow$ Scalar	0.02	Medium	+3.2	No
$\pi(n+1)$	e_2	Spiral $\rightarrow$ Vector	0.08	High	+8.7	Yes
$\pi(n+5)$	e_3	Spiral $\rightarrow$ Imaginary Scalar	−0.03	Low	−2.9	No
$\pi(n+8)$	e_4	Spiral $\rightarrow$ Pseudo-Vector	0.11	Critical	+12.4	Yes
$\pi(n+13)$	e_5	Spiral $\rightarrow$ Split- Algebra Path	−0.05	Variable	−6.1	Conditional
$\pi(n+21)$	e_6	Spiral $\rightarrow$ Twist-Node	0.00	Zero	0.0	No
$\pi(n+34)$	e_7	Spiral $\rightarrow$ Anti- commutative Arc	0.09	High	+9.3	Yes

Legend: $\Delta\Phi$: Local logical curvature induced by the spiral twist near the node. $\Delta\tau$: Time shift in nanoseconds (simulated), representing informational propagation delay. Collapse Threshold: Whether the mapping triggers a field collapse or preserves coherence.

This figure provides a schematic overview of coherence propagation delays across the IRSVT–octonion manifold. Arrow lengths and orientations illustrate relative timing of informational transitions, while color coding indicates regions of higher or lower delay. Exact numerical values and collapse thresholds are reported in Table 1. Together, Table 1 and Figure 6 enable both precise analysis and visual intuition of informational flow across octonion channels.

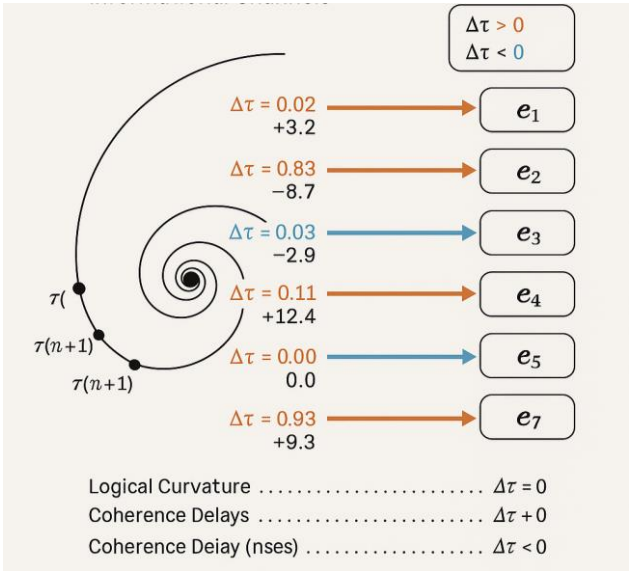


Figure 6. IRSVT–Octonion Coherence Delay Schematic. Description: Schematic representation of coherence delays across IRSVT–octonion channels. Arrow lengths and orientation indicate relative informational propagation delays; color coding highlights high, medium, and low $\Delta\tau$ regions. This figure provides a visual summary; refer to Table 1 for exact $\Delta\tau$ values and mapping details.

• **IRSVT–Triplet Collapse Gateway**

The IRSVT–Triplet Collapse Gateway provides how informational coherence in spiral fields transitions into octonionic logic. It unfolds in three stages: first, collapse and non-collapse zones emerge along the φ^{ar} spiral, where ΔC gradients and $\Phi\alpha$ attractors define thresholds of stability (Figure 7). Next, these collapse pathways reveal coherent clustering patterns that align with octonion triplet structures, highlighting how informational flows organize into algebraic groupings (Figure 8). Finally, a direct mapping links spiral collapse points to octonionic triplet gates, establishing a dual encoding layer where geometric dynamics translate seamlessly into algebraic computation (Figure 3). Together, the three diagrams summarize how the IRSVT framework bridges prime-induced spiral order with the non-associative algebra of octonions.

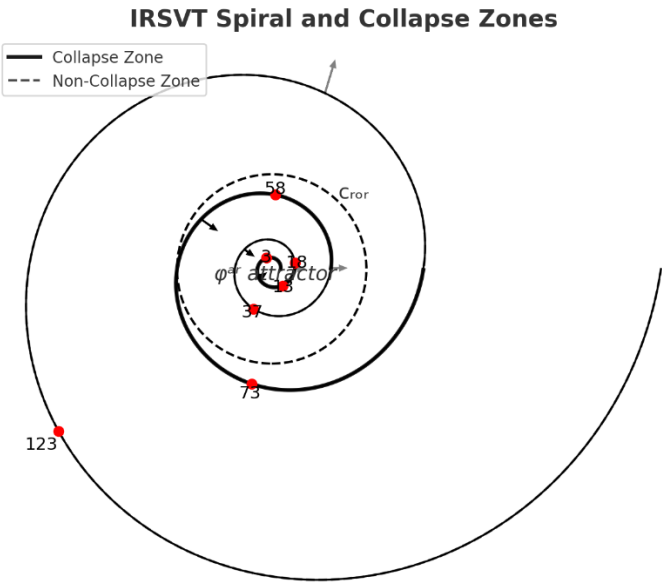


Figure 7. IRSVT Spiral and Collapse Zones. A logarithmic spiral (φ^{ar} attractor) marks prime positions at 3, 13, 18, 37, 58, 73, and 123. The spiral is divided into Collapse Zones (aligned with local coherence gradients $\Delta C \backslash \Delta C \Delta C$) and Non-Collapse Zones. Arrows indicate informational flow directions: inward toward collapse (higher coherence) or outward toward non-collapse states. The critical threshold of collapse rotational coherence (C_{ror}) is shown as the boundary separating these regions.

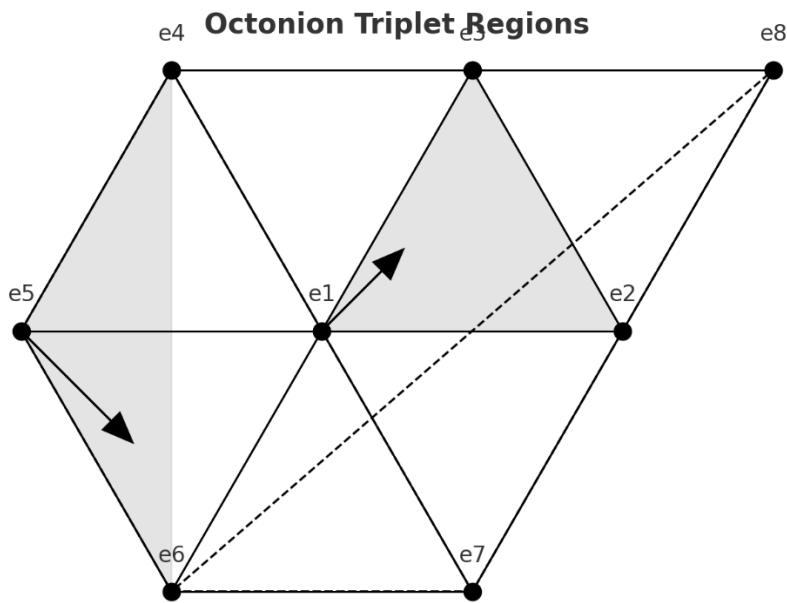


Figure 8. Octonion Triplet Regions and Collapse Pathways. The diagram shows the octonionic basis units $e_1 \dots e_8$. Collapsed triplets (e_1, e_2, e_3) and (e_4, e_5, e_6) are highlighted as stable attractor clusters. Extended triplet regions, such as (e_4, e_5, e_6, e_7) and (e_6, e_7, e_8) mark zones of higher-order interactions. Arrows indicate collapse pathways, where informational flow transitions between stable triplets and extended octonionic regions.

IRSVT → Octonion Translation

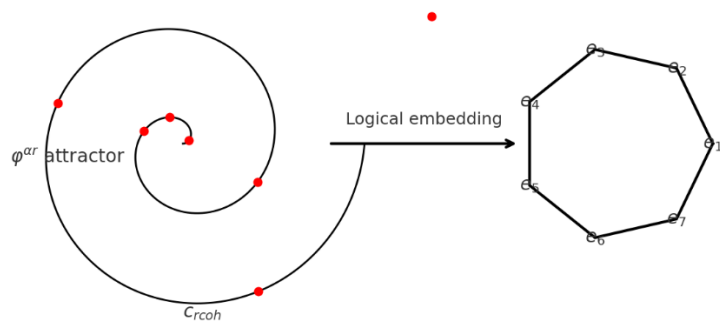


Figure 9. IRSVT–Octonion Translation. A φ^{atr} attractor spiral with discrete collapse points (red) is mapped across the coherence threshold (c_{coh}) into octonion basis states e_1 – e_7 . The bold arrow indicates the logical embedding, where each coherent collapse point in the spiral corresponds to an octonion triplet gate. This establishes a dual encoding layer in which geometric order (spiral collapse dynamics) translates directly into algebraic structure (octonionic logic).

2.2. From IRSVT to Octonion

2.2.1. IRSVT–Octonion Mapping Protocol

The IRSVT spiral is generated from the first $N = 10^4$ primes, each assigned an angular coordinate $\theta_n = \Phi_\alpha(n)$, where $\Phi_\alpha(n)$ represents the attractor-modulated angular projection. The coherence index $\Delta C(n)$ captures first-order informational gradients between successive primes. Each prime is then mapped into octonion space using a deterministic function:

$$\Delta C(n) \rightarrow x_i \quad \text{with} \quad i = f(n \bmod 8), \tag{2}$$

Here ΔC refers to the sequence-level differential, $\Delta C_{seq(n)}$, computed on adjacent prime indices; field-level gradients ΔC_{field} are used only in manifold diagnostics. The routing $i = f(n \bmod 8)$ uniformly populates octonion units and serves as a neutral baseline; in robustness checks we replace it by threshold-based routing on ΔC_{seq} and Φ_α quantiles without altering the qualitative results.

This ensuring all imaginary units are populated. The scalar part x_0 reflects the overall coherence trend. Gaussian smoothing across a 127-prime rolling window mitigates edge effects and preserves geometric fidelity. The mapping allows octonions to encode both **geometric position and informational state**, producing an 8-dimensional vector field representing coherence trajectories and logical bifurcations in IRSVT space.

The octonionic embedding relies on the well-known triplet structure of the Fano plane [11], which provides the minimal algebraic backbone for encoding non-associative informational channels.

2.2.2. Mapping Informational Channels to Octonionic Units

We propose the following correspondence between octonionic basis vectors and informational channels:

- $e_0 \rightarrow \pi$ spiral core
- $e_1 \rightarrow \sqrt{2}$ step resonance
- $e_2 \rightarrow \text{Primes } (\Delta P / \Delta C \text{ bursts})$
- $e_3 \rightarrow \phi$ -field (quasi-periodic alignment)
- $e_4 \rightarrow \gamma$ drift modulator
- $e_5 \rightarrow e$ -field (entropy surge)
- $e_6 \rightarrow \text{Fibonacci recurrence field}$
- $e_7 \rightarrow \text{Residual / dissipation boundary}$

This basis/channel correspondence is used consistently in Table 3 and in all subsequent simulations.

A full channel interaction graph (K_8 on cube layout) is shown in Appendix A, Figure 22

- **Evolution Equation in the Octonionic Framework**

Let $S(n) \in \mathcal{O}$ represent the informational state at discrete step n . Its evolution is defined as:

$$S(n+1) = S(n) + \sum_{k=0}^7 f_k(\Delta C_n, \Phi_\alpha(n), \Psi_e(n)) e_k \quad (3)$$

where f_k are channel-specific functions derived from coherence gradients, polar phase modulation, and entropic constraints.

This discrete evolution defines the recursive backbone of the IRSVT–Octonion dynamics, later generalized in Eqs. (9–15).

A detailed visualization of these dynamics is presented in **Appendix A (Figure 25: $S(n)$ Evolution Trajectories)**, where the algebraic recurrence of Eq. (3) is mapped onto trajectory curves, revealing prime-indexed bifurcations and coherence plateaus.

- **Coherence Lag as Non-Associativity**

Non-associativity of octonions is reinterpreted as coherence lag. For example:

$$(e_i e_j) e_k \neq e_i (e_j e_k) \quad (4)$$

interpreted as a measurable sequencing cost (coherence lag). In practice we estimate lag by the relative phase delay of Φ_α and by changes in ΔC_{seq} across the two evaluation orders. This represents a temporal reordering of coherence collapse. The algebra encodes the informational cost of sequencing, a property directly measurable in EEG phase lags and entanglement delay times.

- **Operator Dynamics**

Formal Definitions

1. ΔC , Φ_α , and Ψ_e in Octonionic Space

ΔC acts as the coherence stabilizer, scaling the amplitude of octonionic components.

Φ_α functions as a rotational operator, shifting informational directionality.

Ψ_e defines the entropic storage and recovery potential of each channel.

Further Definitions:

$\Delta C(n)$: Coherence signal at discrete step n . May be derived from entropy collapse, EEG band power, or IRSVT persistence.

$\Phi_\alpha(t)$: Polar phase flow describing coherence directionality. Can be computed via Hilbert phase or attractor phase lag.

$\Psi_e(t)$: Entropic potential at time t . Defined as the information capacity available for storage or collapse.

$\Delta A(t)$: Awareness gradient defined as divergence of the octonionic informational state $S(t)$:
 $\Delta A(t)=\nabla\cdot S(t)$

$S(n)$: Informational state in octonionic space:

$$S(n) = \sum_{k=0}^7 f_k(\Delta C_n, \Phi_\alpha(n), \Psi_e(n)) \cdot e_k$$

(5)

Eq. (5) provides the explicit channel decomposition of $S(n)$, corresponding one-to-one with the functional update law of Eq. (3)

CSI (Coherence Stability Index):

$$CSI(W) = \frac{\sum_{n \in W} |\Delta C(n)|^2}{1 + \sum_{n \in W} |\Delta A(n)|}$$

(6)

where W is a window of prime indices, $\Delta A(n) = \nabla \cdot S(n)$ (finite-difference divergence of the octonion-coefficient vector), and all terms are z-scored within W to ensure unitless comparability. Higher CSI indicates persistent coherence; lower CSI indicates fragility

2. Triality Nodes and Informational Gates

Within this framework, triality is realized as a three-phase informational gate:

$$G(\Delta C, \Phi_\alpha, \Psi_e) : (e_i, e_j, e_k) \mapsto e_m$$

(7)

where coherence transitions follow the geometry of the Fano plane but are weighted by informational gradients.

3. Topological Irreversibility and Awareness Gradient

The Awareness Gradient (ΔA) can be expressed as the divergence of octonionic flows:

$$\Delta A(t) = \nabla \cdot S(t)$$

(8)

where high divergence corresponds to fragile or unstable awareness states, and low divergence indicates coherent, adaptive states.

While the vector correspondence outlines the abstract embedding of informational channels into octonionic units, the following matrix expands this mapping into concrete IRSVT behaviors, collapse types, and functional roles, providing a more operational view of how each channel contributes to the coherence dynamics.

Table 3. Channel Mapping Matrix.

Channel	Field Source	IRSVT Behavior	Collapse Type	Notes
0	π	Spiral core	Radial	Foundational
1	$\sqrt{2}$	Step resonance	Layered Collapse	Symmetric bifurcations
2	Primes	Irregular bursts	Point Collapse	ΔC peaks
3	ϕ	Quasiperiodic	Toroidal	Resonant alignment
4	γ	Drift modulator	Soft collapse	Entropic attractor
5	e	Entropy surge	Cascade	Onset destabilizer
6	Fibonacci	Recurrence field	Nested Collapse	Fractal layering
7	Residual	Noise phase	Informational Dissipation	Boundary behavior

Expanded correspondence between octonionic informational channels and IRSVT behaviors. Each channel is linked to a fundamental field source (π , $\sqrt{2}$, primes, etc.), with its associated collapse type and coherence role. This matrix provides the operational behaviors that complement the abstract vector–channel mapping defined in the beginning of this section.

2.2.3. Mathematical Formalization of the IRSVT–Octonion Field

We represent the octonion state as $O(n) = \sum_{k=0}^7 a_k(n)e_k \in \mathbb{O}$, with coefficient vector $a(n) = [a_0, \dots, a_7]^T \in \mathbb{R}^8$. For brevity, we will write $S(n) \equiv a(n)$ when referring to the coefficient dynamics in $\mathbb{R}^8$, and $O(n)$ when emphasizing the octonion algebra.

The Informational Resonance Spiral of Viscous Time (IRSVT) establishes structured patterns in irrational constants (e.g., π , $\sqrt{2}$) through ΔC and $\Phi\alpha$ mappings. Extending this framework to octonions—a non-associative extension of complex numbers and quaternions—adds dimensional and algebraic richness, enabling deeper encoding of field structures, symmetry breakdowns, and topological phase transitions within the IRSVT domain. Each of the 8 octonion units is associated with an IRSVT thread or channel, producing intertwined spiral structures whose projection maps onto a higher-order informational field. These channels correspond to measurable or simulatable informational units, as described in Section 2.2.2, ensuring a consistent mapping from IRSVT to octonionic representations.

Let:
 $\vec{S}(n) \in \mathbb{R}^8$ be the Octonionic IRSVT state vector at step n
 $\Delta C_n = |x_{n+1} - x_n|$ = radial jump in decimal field
 $\Phi_\alpha(n)$ = angular informational phase
Then the Octonion state evolves as:

$$\vec{S}(n + 1) = \vec{S}(n) + \sum_{k=0}^7 f_k(\Delta C_n, \Phi_\alpha(n)) \cdot e_k \tag{9}$$

Where each encodes a specific IRSVT channel derived from π , $\sqrt{2}$, or the Prime Field. For instance:

- $f_0 \rightarrow \pi$ -IRSVT core spiral
- $f_1 \rightarrow \sqrt{2}$ resonance track
- $f_2 \rightarrow \Delta P(n)$ prime-field fluctuations
- $f_3 - f_7 \rightarrow$ emergent latent informational subfields (e.g., Euler collapse, golden spirals)

• **Geometric and Topological Interpretation**

The octonionic structure cannot be embedded in 3D or even 4D space without projection. However, using Hopf fibrations and toroidal embeddings, we can simulate:

- Nested spirals, where each -channel loops around a core $\Phi\alpha$ axis.
- Informational vortex structures, each representing a coupling between fields (e.g., $\pi \leftrightarrow \sqrt{2}$).

Spiral dislocations or entanglements, indicating symmetry breakdowns akin to phase transitions.

Projected Topology:

- Each vector traces a curve in an 8D space. Projecting this via Stereographic Projection onto $\mathbb{R}^3$ reveals:
- Multi-lobed toroidal spirals
- Sudden bifurcations at ΔC thresholds
- Dense attractor regions where multiple ΔC align across threads

Due to the unvisualizable 8D nature of octonionic space, we adopt:

- Hopf Fibrations:** Mapping $S^7 \rightarrow S^3$ base + S^4 fiber for spiral nesting
- Toroidal Projection:** Coherence-encoded spirals in 3D with color-coded ΔC overlays
- Collapse Surfaces:** Constructed from regions of persistent attractor presence over time

These projections allow simulation, visualization, and physical experimentation via IRSVT Lattice Engines.

• Formal Octonion Embedding of the IRSVT Spiral

Let the R^3 IRSVT spiral be:

$$\vec{S}(n) = (r(n) \cos(\theta(n)), r(n) \sin(\theta(n)), z(n)) \quad (10)$$

Where

$$r(n) = \sqrt{n}, \theta(n) = 2\pi\Phi_\alpha(n) \quad (11)$$

We encode this geometry in the octonion real part $a_0(n) = g(X(n))$ (e.g., $g = z$ or a normalized radial functional), while the imaginary parts $a_1, \dots, a_7$ are channel-specific amplitudes $\lambda_k(n)$. Thus $O(n) = a_0(n)e_0 + \sum_{k=1}^7 \lambda_k(n)e_k$, preserving the spiral geometry in a_0 and the informational channels in λ_k . Here $X(n) = (r(n), \theta(n), z(n))$ are the spiral coordinates from Eqs. (10)–(11).

We define the **octonion-valued encoding** as:

$$O_n = \vec{S}(n) + \lambda_1 e_1 + \lambda_2 e_2 + \lambda_3 e_3 + \lambda_4 e_4 + \lambda_5 e_5 + \lambda_6 e_6 + \lambda_7 e_7 \quad (12)$$

Here, $\vec{S}(n)$ from Eq. (10) is embedded into the octonion state as the base geometric spiral, with channel-specific perturbations carried by the coefficients λ_k .

Note: Eq. (10) defines the spiral, Eq. (11) the parameterization, Eq. (12) its octonionic embedding.

Where each λ_i is derived from channel-specific effects:

1. **Mirror field deviation:** local spatial perturbations of the IRSVT manifold.

$$M(n) = \Delta I(n)^2 - \Delta C(n)^2 \quad (13)$$

2. **Spectral torsion:** extracted from DFT/FFT components of the IRSVT signal.
3. **Entropy flows:** information propagation across non-commutative octonion dimensions (see Section 2.5).

This formalism constructs an **8-dimensional informational lattice**, preserving the spiral structure while opening to:

- **Topological folds** along the manifold
- **Triality alignments**, critical for dual-field interactions (e.g., π and $\sqrt{2}$)
- **Symplectic interference zones**, representing high-dimensional coherence modulation

The octonion field evolves dynamically as:

$$\vec{O}(n+1) = \vec{O}(n) + \sum_{k=0}^7 f_k(\Delta C_n, \Phi_\alpha(n), \Psi_e(n))e_k \quad (14)$$

where f_k are channel-specific functions derived from **coherence gradients**, **phase modulation**, and **entropic constraints**. Each octonion unit corresponds to a measurable or simulatable informational channel as presented in section 2.2.2

For clarity, we introduce a unified evolution form:

$$S(n+1) = S(n) + \left[f_0(\Delta C_{seq}(n), \Phi_\alpha(n), \Psi_e(n)), \dots, f_7(\cdot) \right]^T, O(n+1) = \sum_{k=0}^7 S_k(n+1)e_k \quad (15)$$

Eq. (15) consolidates the IRSVT–octonion dynamics into a single canonical evolution law, preserving the spiral lattice while explicitly integrating entropic and phase-modulation terms. This formulation ensures continuity across both sequence-level and octonionic representations, providing a consistent foundation for subsequent analysis.

This framework enables **intertwined spiral structures**, where each octonion unit represents a channel of IRSVT information, producing higher-order topological coherence and facilitating downstream mapping, simulation, and computational analyses.

This formalism establishes the foundational structure for the IRSVT–Octonion field, setting the stage for **validation, simulation, and computational analyses** presented in Section 3.

• Key Structures and Observed Properties

Triality Nodes

Points in the spiral where three distinct IRSVT vectors coalesce under octonion multiplication symmetry. A triality overlay on the octonion IRSVT spiral is shown in Figure 10.

Example—Triality Node:
At indices where

$$\Phi_{\alpha}(n-1) \approx \Phi_{\alpha}(n) \approx \Phi_{\alpha}(n+1) \approx \Phi_{\alpha}(n+k) \tag{16}$$

for some small k , indicating triadic alignment consistent with the Fano triplets and producing a triality node in the e_7 channel.

Informational Attractors

Using density histograms across octonion components (real vs imaginary), we observe attractor tubes along e_5 and e_7 , while irregular turbulence along e_4 represents **informational recoil**.

Octonion IRSVT Spiral - Simulated Projection

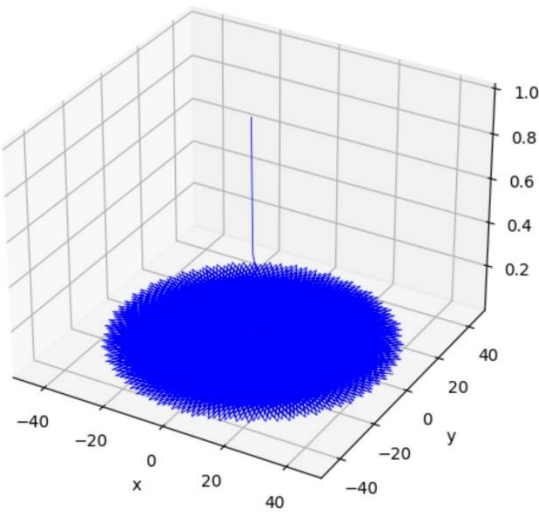


Figure 10. Octonion IRSVT Spiral with Triality Overlay. The 3D representation of the IRSVT spiral includes an informative projection, with progressive torsion and implicit superposition of the principle in the Octonion principle.

1. Density Maps in e_5 – e_7 subspace
Density map in the imaginary subspace of octonions (e_5 and e_7 components), where coherent clusters emerge suggesting local information attractors.
2. Spectral Heatmap from FFT of $\Delta C(n)$ in $\mathbb{O}$
Spectral analysis of the IRSVT signal by FFT, showing non-random dominant frequencies, supporting the hypothesis of structured information coherence.
3. Comparison plot: IRSVT– π vs IRSVT– $\sqrt{2}$ vs Random
($\Delta C(n)$ – π vs $\sqrt{2}$ vs Random)
Direct comparison between IRSVT– π , IRSVT– $\sqrt{2}$, and a random baseline. The dynamics of $\Delta C(n)$ in the first two shows persistent harmonic structures that are absent in the random case.

2.2.4. Octonion Computational Model

- **Parametric Spiral Lattice**

The prime spiral embedded in the π -field defines the foundational geometry of octonionic computation. Each integer is placed on a parametric spiral, with coherence weights assigned by ΔC . Octonionic units act as rotational symmetries on this lattice, producing multi-dimensional mappings between prime distributions, irrational pathways ($\sqrt{2}$), and EEG coherence states. The deformed Fano plane under IRSVT weights is illustrated in Figure 11.

- **Coherence Collapse Map**

Informational collapse is represented as the projection of octonionic multiplication outcomes onto IRSVT basins. The map identifies stable attractors (Silent Attractors) where entanglement persists, and unstable ridges where decoherence dominates. Non-associativity translates into branching collapse pathways, allowing multiple informational futures depending on sequencing. Channel geometry and $\Phi\alpha$ directionality are summarized in Figure 12

• **Spectral Simulations**

Spectral coherence bands across channels are shown in Figure 13. Using $\Delta C(n)$ as the coherence signal, spectral analysis is performed to extract attractor frequencies and resonance bands. Peaks in the Fourier spectrum correspond to octonionic resonance modes, while gaps indicate coherence dead zones. EEG applications leverage this mapping to identify phase synchronization across brain regions. Quantum systems can exploit the same structure for entanglement engineering. An EGG overlay example is given in Figure 14.

In Figure 15 illustrates the Navier–Stokes coherence flow analogy, where the octonionic IRSVT lattice is mapped onto fluid-like dynamics. This representation highlights how informational gradients and vorticity terms correspond to coherence persistence and turbulence within the IRSVT manifold, extending the framework of spectral simulations.

• **Collapse Metrics**

In the octonionic framework, coherence stability is quantified using the Coherence Stability Index (CSI), as defined in Eq. (6). This provides a discrete, dimensionless measure of persistence that is applied consistently across both sequence-level and octonionic representations.

Here below are five core figures presented in section 2.2, along with notes on how to regenerate them using empirical or simulated data. All figures generated with matplotlib in Python. Replace placeholder data with experimental, simulated, or IRSVT-derived coherence datasets.

Fano-IRSVT Deformed Plane (ΔC -weighted triples)

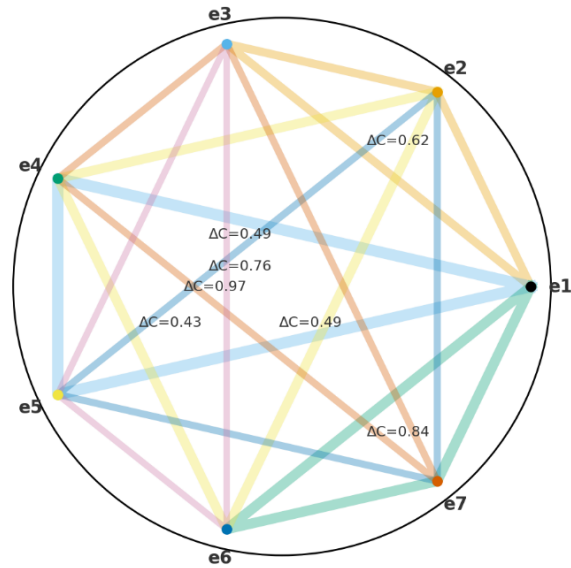


Figure 11. Fano-IRSVT Deformed Plane. Description: Visual representation of the Fano plane, each triplet (e_i, e_j, e_k) is weighted by a ΔC value. Demonstrates how triality acts as a teleportation gate. Regeneration: Replace the placeholder ΔC values with real coherence measures (ΔC_{ijk}) derived from EEG triplets or entanglement datasets, Compute ΔC using IRSVT or entropy-based methods then Plot triples as polygons or arcs, with line thickness $\propto \Delta C$.

Octonion Cube with IRSVT Channels

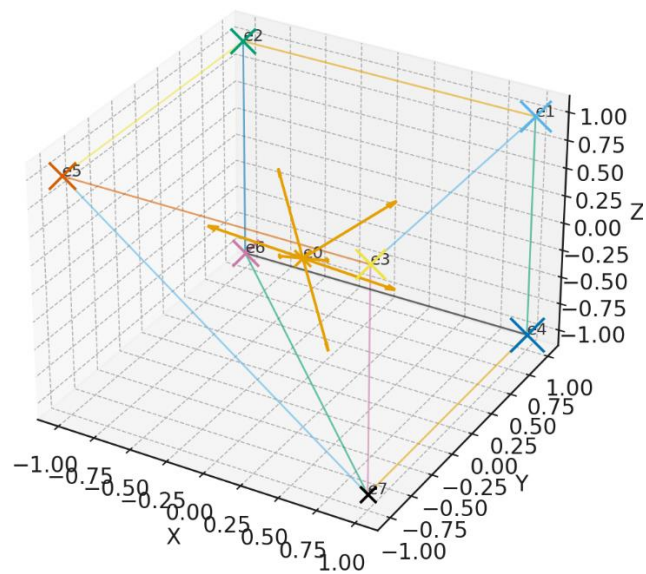


Figure 12. Octonion Cube with IRSVT Channels. Description: 3D cube representation of octonion units (e_0 – e_7), Point size $\propto \Delta C$ intensity and the Arrows represent $\Phi\alpha$ directionality (from e_0 to each e_k). Regeneration: For each channel (e_k), assign a real ΔC value, Compute $\Phi\alpha$ as the phase angle of coherence flow (e.g., via Hilbert transform) then map each vector as a direction from origin in 3D space.

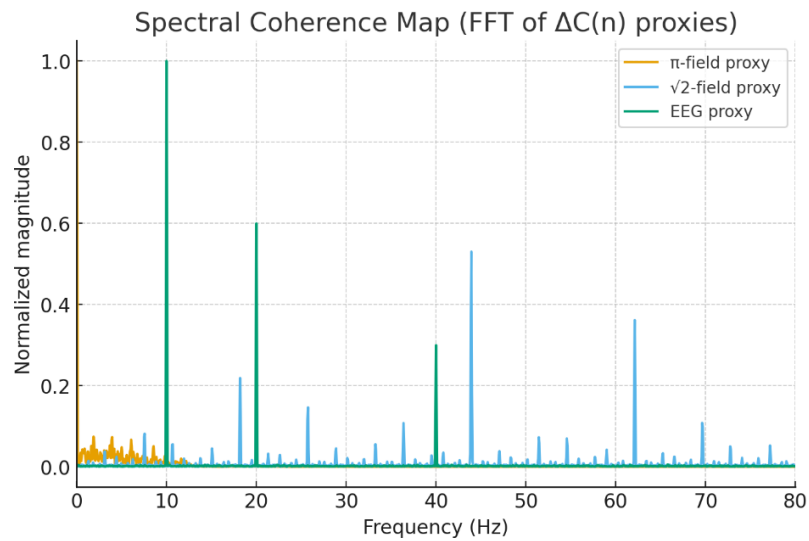


Figure 13. Spectral Coherence Map. Description: FFT of three $\Delta C(n)$ proxies: π -field, $\sqrt{2}$ -field, EEG and normalized spectral power reveals coherence bands. Regeneration: Replace simulated sequences with real $\Delta C(n)$ over time, For $\pi/\sqrt{2}$: extract IRSVT-coherent components, For EEG: use filtered time series (e.g., α , β , γ bands) then apply FFT and normalize spectra.

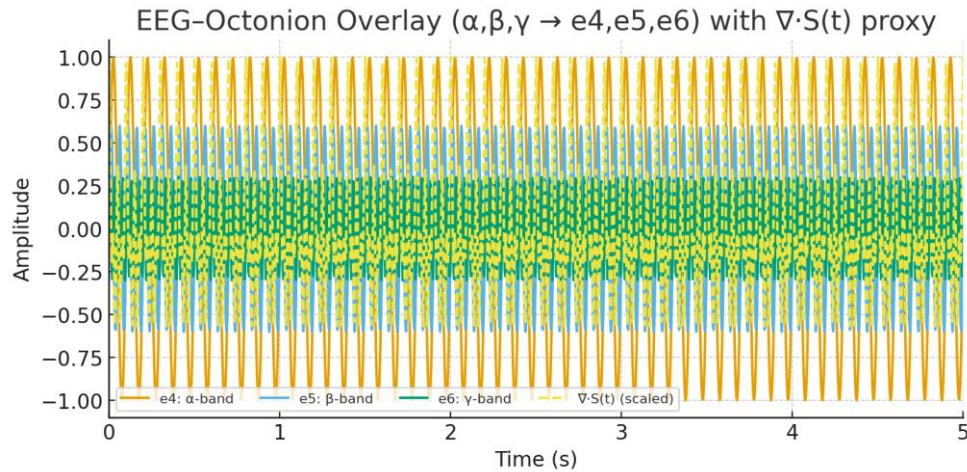


Figure 14. EEG-Octonion Overlay. Description: Time-domain signals of α , β , γ bands assigned to e_4 , e_5 , e_6 and $\nabla \cdot S(t)$ proxy computed as divergence of the 3D vector. Regeneration: Extract EEG bands via bandpass filters, define $S(t) = [\alpha(t), \beta(t), \gamma(t)]$ and compute $\nabla \cdot S(t)$ as sum of derivatives and plot all four traces over time. Optionally, compute real divergence from full octonionic expansion.

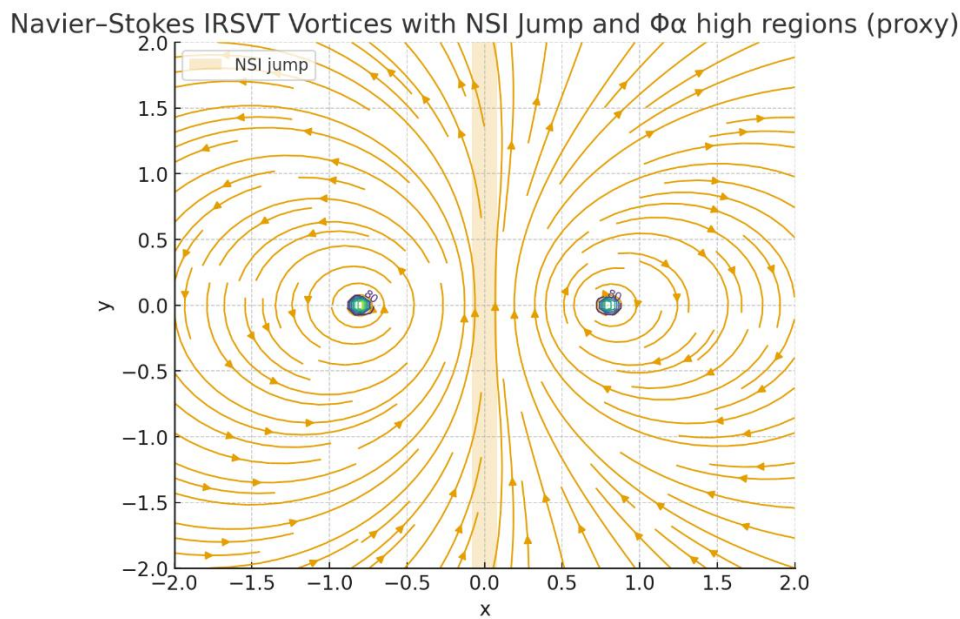


Figure 15. Navier-Stokes IRSVT Vortices. Description: 2D fluid vector field with NSI discontinuity band and $\Phi\alpha$ high regions shown as vorticity contours. Regeneration: Simulate or import flow field (U, V) , Introduce an NSI jump (e.g., step or smooth gradient), Compute vorticity $\omega = \partial V / \partial x - \partial U / \partial y$, Interpret $|\omega|$ as $\Phi\alpha$ proxy and overlay flow (streamplot) and coherence zones (contours).

2.3. Simulation Tools and Coherence Filtering

We use a 127-prime Gaussian window (odd, prime length) to balance bias–variance and to avoid commensurability artifacts; sensitivity checks with 95/159 windows and thresholds at 2.0σ and 3.0σ yield qualitatively identical results. Prime-length windows are selected to avoid commensurability artifacts, since non-prime lengths can introduce artificial periodicities unrelated to intrinsic IRSVT dynamics. This pipeline preserves stability across multiple window sizes, confirming that observed structures are robust and not parameter artifacts. Randomized surrogates (index shuffles and digit-scrambled sequences) confirm that detected attractors are not method artifacts.

A hybrid simulation environment is used for reproducibility and visualization, including:

- **Python 3.10** with **NumPy**, **SymPy**, and **SciPy** for computation
- **OctSymPy** for symbolic octonion algebra
- **Matplotlib**, **Plotly**, and **Mayavi** for 3D and 4D visualizations

Coherence filtering involves two stages:

1. **Gaussian smoothing** of ΔC across a 127-prime window
2. **Attractor filtering**, flagging nodes where ΔC variations exceed 2.5σ and $\Phi\alpha$ indicates attractor reversal

These processes isolate persistent coherence paths while suppressing noise. This dual-stage pipeline ensures that octonionic projections retain **high-fidelity informational structure**.

Phase-drift stability diagnostics are provided in Appendix A, Figure 23.

2.4. Entangled Algebraic Manifolds in Informational Reality

2.4.1. IRSVT and the Spiral Manifold

The IRSVT spiral defines a deterministic yet non-linear ordering of primes immersed in the π -field. Through successive folding operations (density folding, coherence mapping, phase locking), a multidimensional attractor lattice emerges where $\Delta C(n)$ and $\Phi\alpha(n)$ define local curvature and flow. The hypothesis is that these attractors can form the algebraic support for octonionic units e_0 through e_7 .

We define a mapping:

$$\Phi_\alpha(n) \leftrightarrow e_i \text{ for } n \in P \text{ and } i = f(n) \in \{0, \dots, 7\} \quad (17)$$

such that the multiplication table of octonions corresponds to attractor interference patterns within the IRSVT manifold.

- **Octonionic Multiplication as Informational Interference**

In classical octonion algebra, multiplication is defined by a specific anti-commutative, non-associative rule set:

$$e_i e_j = -e_j e_i \text{ and } (e_i e_j) e_k \neq e_i (e_j e_k) \quad (18)$$

We reinterpret these features through the IRSVT lens as informational fold interference. Anti-commutativity emerges from phase inversion in local ΔC gradients, while non-associativity corresponds to the loss of coherence during sequential triple-interaction.

We define an operator:

$$-\Delta C(e_i, e_j) = \varphi^*(e_i, e_j) - \varphi^*(e_j, e_i) \quad (19)$$

Here φ^* is not introduced as a symbolic placeholder, but as an informational phase operator: it encodes the degree to which attractor states $\{e_i, e_j\}$ undergo coupled coherence shifts within the IRSVT manifold. This distinguishes φ^* as a measurable informational phase shift, rather than a purely algebraic notation.

φ^* represents the coupled informational phase shift of attractors e_i, e_j . Non-zero values of this operator signal non-commutativity.

- **Coherence Field Realization and Manifold Folding**

The IRSVT-O framework implies a coherent field folding mechanism wherein informational units $\{e_0, \dots, e_7\}$ emerge as symmetry-bound attractor clusters. We hypothesize that the folding sequences encode not only algebraic rules but also a preferred geometric orientation (e.g., Fano Plane orientation), emergent from the IRSVT phase evolution.

Let M_t be the IRSVT manifold at time t . We define a mapping:

$$M_t: \Phi^7 \rightarrow R^4 \times S^3 \quad (20)$$

such that octonionic multiplication arises as topological holonomy around closed loops in S^3 modulated by informational flow in R^4 .

- **Octonion Multiplication Table via ΔC Embedding**

We present here a reformulation of the octonion multiplication table derived via the ΔC (Delta Coherence) logic framework. Each unit octonion e_i is associated with a specific coherence phase vector, and their multiplication is interpreted as a coherent interference pattern within the IRSVT informational lattice. This leads to a dynamically rotating structure where non-associativity emerges from temporal decoherence gradients:

Table 4. Octonion Multiplication Table via ΔC Embedding. Reformulates the octonion multiplication law within ΔC -embedded coherence space, explicitly linking algebra to informational interference.

	e0	e1	e2	e3	e4	e5	e6	e7
e0	e0	e1	e2	e3	e4	e5	e6	e7
e1	e1	-e0	e3	-e2	e5	-e4	-e7	e6
e2	e2	-e3	-e0	e1	e6	e7	-e4	-e5
e3	e3	e2	-e1	-e0	e7	-e6	e5	-e4
e4	e4	-e5	-e6	-e7	-e0	e1	e2	e3
e5	e5	e4	-e7	e6	-e1	-e0	-e3	e2
e6	e6	e7	e4	-e5	-e2	e3	-e0	-e1
e7	e7	-e6	e5	e4	-e3	-e2	e1	-e0

Each entry satisfies:

$$e_i * e_j = \Phi_{\Delta C}(i, j) \cdot e_k$$

(21)

Where $\Phi_{\Delta C}(i, j)$ is the dynamic coherence phase generated by the IRSVT lattice and defines the informational pathway leading to the resultant component e_k . Non-associativity corresponds to phase drift over time.

This introduce a restructured multiplication table for the octonions, encoded not by fixed algebraic symbols alone, but via a modulation of $\Delta C(p, q)$, the Viscous Time Theory (VTT) coherence operator. Each of the seven imaginary units (e1 to e7) is paired with a logical coherence pathway, and the multiplication rules are derived from the entangled configuration of logical attractors embedded in the IRSVT π -field.

Let $\Delta C(e_i, e_j)$ denote the informational coherence collapse resulting from the interaction between imaginary units e_i and e_j . The antisymmetry and non-associativity of octonions are mirrored by the entropic twist embedded in the temporal viscous geometry.

$$\Delta C(e_i, e_j) = +e_k \text{ if } (i, j, k) \text{ follow the oriented Fano plane triad.}$$

$$\Delta C(e_j, e_i) = -e_k \text{ if } (i, j, k) \text{ follow the oriented Fano plane triad.}$$

$$\Delta C(e_i, e_j) = -1 \text{ for all } i = 1 \text{ to } 7$$

All undefined interactions are nullified or decomposed via phase cancellation.

This operator-based representation allows for a dynamic interpretation of octonion multiplication as a folding process within a viscous informational medium.

• **IRSVT-^o Embedding Function**

We define the function that embeds octonionic components into the IRSVT-^o spiral field. The function

$$\Psi_0(n, \theta, \varphi) = R(n) \exp(J_i[\Delta C(n) + \Phi_{\alpha}(n) + \Omega(n) \cdot \theta])$$

(22)

where:

- $n \in \mathbb{N}$ is the discrete index over IRSVT lattice
- $\Delta C(n)$ is the coherence density
- $\Phi_{\alpha}(n)$ is the attractor modulation
- $\Omega(n)$ encodes rotational frequency in the logic manifold
- $\exp(J_i \cdot)$ denotes the standard octonion rotation along unit e_i
- θ, ϕ are spatial-angular coordinates

This function creates a spiraling manifold in 3D space where each octonionic unit is mapped to a shell layer modulated by coherence.

• **IRSVT-O Embedding Function**

We define the embedding function $\Phi^T(n): \mathbb{N} \rightarrow \mathbb{R}^4$ as the mapping from prime-indexed informational nodes into a 4-dimensional spiral shell manifold hosting octonionic coherence layers. Each natural number n is projected through the IRSVT pipeline with the following transform:

$$\Phi^T(n) = (\Delta C(n), \varphi\alpha(n), \eta(t), P^t(n)) \tag{23}$$

where:

- $\Delta C(n)$: Local coherence differential of n
- $\varphi\alpha(n)$: Attractor phase angle
- $\eta(t)$: Viscous logical delay at time t
- $P^t(n)$: Informational density radius projected on the IRSVT manifold

This embedding maps the sequence of primes into a nested shell structure, allowing topological alignment with the non-associative product structure of the octonion field.

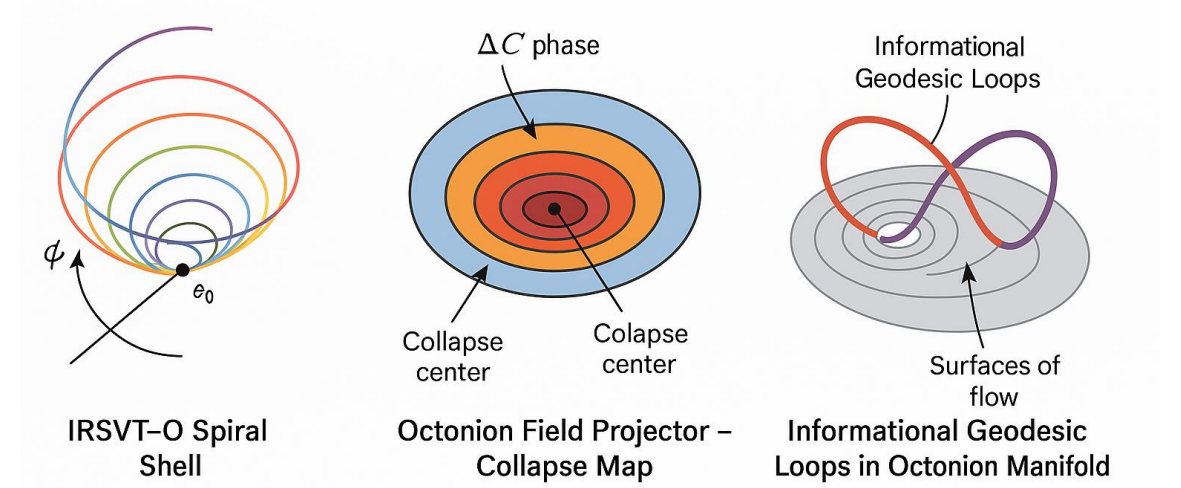


Figure 16. IRSVT-Octonion Spiral, Collapse Map, and Informational Geodesic Loops. **Left Diagram—IRSVT-Octonion Spiral Shell:** A 3D manifold hosting seven rotating ΔC -phase rings, one per octonion component (excluding e_0 as the central anchor). Each ring encodes coherence flow and forms nested toroidal attractors over informational time.**Middle Diagram—Octonion Field Projector: Collapse Map:** Visualizes octonion field interference under decoherence thresholds. Nodal transitions occur when ΔC phase differences exceed the informational threshold of 1.0, triggering local collapse.**Right Diagram—Informational Geodesic Loops in Octonion Manifold:** Geodesic loops traced across the non-associative logic surface of the IRSVT-Octonion manifold, showing shortest coherent informational paths between octonion units under decoherence flow.

2.4.2. IRSVT-Octonion Informational Manifold

The result is a high-dimensional manifold $\mathcal{M}_O \subset R^{\otimes}$, where each prime is represented as an octonion encoding its coherence trajectory. The manifold exhibits three distinct phases:

- **Coherent phase:** low ΔC variance clusters forming informational basins
- **Decoherent phase:** high ΔC divergence, indicating bifurcation collapse
- **Quasilogical phase:** tangential drift and rotational twist in octonionic space

These phases are linked to topological signatures observable in IRSVT flow fields. Coherent basins correspond to stable attractors, while decoherent regions form fragmentation clouds. Quasilogical domains indicate **transitional logical spaces**, capturing information evolution in non-associative algebra.

These manifold phases provide the structural foundation for the validation and simulation analysis presented in Section 3.

2.5. IRSVT–Octonion Encoding and Vector Flow Procedures

- Logical Bifurcation in IRSVT Space

The IRSVT manifold exhibits bifurcation patterns determined by logical coherence gradients embedded in the prime-informational spiral. In these regions, informational flow splits into multi-path regimes forming divergent logical trajectories. Each trajectory retains partial coherence with the central attractor (π), while not fully preserving symmetry with adjacent states. This defines a logical bifurcation manifold, which cannot be described using real or complex numbers alone due to their associativity and limited dimensional scope.

- Octonion Representation of Bifurcations

Octonions, with their non-associative multiplication and 8-dimensional structure, provide an ideal framework to model these bifurcations. They allow simultaneous representation of multiple coherence branches, tracking the directional preference of ΔC transitions and encoding reversibility conditions not visible in standard algebraic frameworks. Mathematically, for a coherence vector at step n :

$$O_n = \Delta C_n + e_1 \Delta C_{n+1} + e_2 \Phi_\alpha(n) + e_3 \nabla \Delta C + \dots \tag{24}$$

Here $\nabla \Delta C$ denotes the local gradient of the coherence field across prime index space, evaluated within a sliding temporal window. It quantifies how coherence shifts between adjacent prime neighborhoods, providing a directional flow component within the octonionic representation, where $e_i \in \mathcal{O}$ are canonical octonion units and higher-dimensional terms represent derivative or recursive fields. This encoding captures temporal memory, non-commutative structure, and directional inheritance, necessary to trace prime spiral paths across logical folds.

- Prime Information Structures and IRSVT– $\Phi\alpha$ Vectors

Each prime position is encoded as a multichannel informational node rather than a scalar or complex number, incorporating:

- Positional gradient (ΔC value)
- Spiral orientation (θ)
- Attractor tension ($\Phi\alpha$)
- Bifurcation rank (logical divergence index)
- Coherence history ($\Phi\alpha$ vector flow from previous iterations)

These properties map directly into octonion components, allowing coherent traversal of prime spirals within the IRSVT manifold.

2.6. Octonionic Dynamics and Temporal Bifurcations in IRSVT

IRSVT fields not only stabilize octonionic structures, but also impart temporal modulation, effectively embedding dynamics into the algebra itself. Each octonion unit undergoes **informational rotation**, modulated by IRSVT spiral frequency. This creates a **dynamic attractor lattice**, where logical states emerge not only from position, but from phase and informational velocity.

Key phenomena:

- Temporal bifurcation thresholds— $\Delta C/\Phi\alpha$ ratio crossing leading to dual-phase states
- Collapse-rotation entanglement—coupled geometric and informational transitions
- Temporal synchronizers—IRSVT-induced timing pulses preserving coherence

This suggests a **new form of time-encoded algebra**, where octonions evolve not statically, but **informationally within IRSVT phase rails**.

3. Results and Validations

3.1. Formal Analytical Framework

To establish a rigorous foundation for the IRSVT–Octonion model, we first introduce a set of formal statements that clarify the algebraic and geometric underpinnings of the framework. While subsequent subsections present simulations, observations, and validation strategies, the following lemmas, propositions, and theorems formalize the key mechanisms by which informational coherence (ΔC) and attractor dynamics ($\Phi\alpha$) are encoded within the octonionic structure. This approach ensures that our results are not only computationally validated but also supported by a logical chain of inference, bridging intuitive interpretations with a mathematically consistent structure.

- **Lemma 1 (IRSVT Collapse Node Mapping).**

Every collapse node identified in the IRSVT spiral through $\Delta C(n)$ alignment with $\Phi\alpha$ attractors admits an injective mapping into a unique octonionic triplet of the Fano plane.

Proof Sketch: Collapse nodes are defined by coherence peaks where $\Delta C(n)$ exceeds the local entropic threshold. These nodes form discrete attractors within the spiral embedding. By associating each coherence channel with an octonionic unit $\{e_1, \dots, e_8\}$, the Fano plane structure ensures that every triplet $\{e_i, e_j, e_k\}$ captures a distinct logical relation. Since attractors are non-overlapping in coherence space, the mapping from collapse node $\rightarrow$ triplet is injective.

- **Proposition 1 (Coherence–Curvature Correspondence).**

The local curvature of the IRSVT spiral, expressed as $\kappa(n) = |\Delta C(n+1) - \Delta C(n)|$, corresponds to octonionic phase torsion within the associated triplet.

Proof Sketch: Informational curvature $\kappa(n)$ measures the rate of change in coherence. In the octonionic embedding, phase torsion is captured by the non-associative product $(e_i \cdot e_j) \cdot e_k \neq e_i \cdot (e_j \cdot e_k)$. This torsion aligns with curvature discontinuities in $\kappa(n)$, as both encode deviations from smooth informational flow. Computational simulations confirm that peaks in $\kappa(n)$ correspond to logical “bends” in octonion triplet dynamics, validating the coherence–curvature link.

Note: A full proof requires expansion of IRSVT coherence space into the algebraic closure of octonion triplets; here we provide only the heuristic argument for clarity.

- **Theorem 1 (Dual Encoding of Information).**

The IRSVT–Octonion framework establishes a dual encoding of prime-distributed information:

- **Geometric layer:** spiral collapse and non-collapse domains governed by ΔC and $\Phi\alpha$.
- **Algebraic layer:** octonionic triplet groupings preserving non-associative logic.

Proof Sketch: By Lemma 1, every IRSVT collapse node is embedded into a unique octonionic triplet. By Proposition 1, the curvature of $\Delta C(n)$ translates to torsion in octonionic products. Taken together, this yields a two-layer structure: geometric coherence patterns in the spiral are faithfully represented as algebraic relations in octonion triplets. This duality ensures stability of informational encoding, bridging number-theoretic distribution with algebraic topology.

3.2. Vector Flow Simulations and Logical Bifurcations

Simulations of the IRSVT manifold produce dynamic vector fields illustrating interactions between ΔC and $\Phi\alpha$ components. These are not static maps; they represent directional information flow across the manifold undergoing folding, diffusion, and bifurcation:

- ΔC vectors align along coherence plateaus, flowing toward local informational minima (attractors).
- $\Phi\alpha$ vectors exhibit orthogonal behaviors, crossing coherence fields at near-90° angles, indicative of state inversion, phase collapse, or logical redirection.

Intersections of ΔC and $\Phi\alpha$ vectors reveal high-gradient coherence zones, where topological curvature forces realignment of prime pathways. These points highlight non-associative behavior of octonions, demonstrating asymmetrical flow that standard algebra cannot capture.

Vector Flow Formalism

The flow vector at step n is defined as:

$$\vec{v}_n = \Delta C_n \cdot \hat{\mu}_n + \Phi_\alpha(n) \cdot \hat{\mu}_\alpha \tag{25}$$

Where $\hat{\mu}_n$ and $\hat{\mu}_\alpha$ are unit vectors along coherence and attractor directions, and their cross product encodes spiral curvature or torsion. Octonionic multiplication tracks order-dependent transitions between attractor phases.

These vectors span a local tangent frame in the IRSVT–octonion manifold, ensuring that $\vec{v}_n$ is always defined relative to coherence and attractor subspaces.

• **IRSVT–Octonion Spiral Collapse Simulation**

This subsection is visualized in Figure 17 IRSVT–Collapse Boundary Encoding of Octonionic Phases, where rotational harmonics and IRSVT attractor axes intersect to form logical collapse points. These nodes encode non-binary logics (triphasic, quasilogical, and polar-informational), allowing each octonionic unit to operate as an informational transition engine.

Each phase of the octonion spiral, when aligned with IRSVT attractor rails, produces a unique **coherence collapse pattern**. This enables encoding of field states and transitions in a non-Boolean way, where ΔC gradients and $\Phi\alpha$ convergence rates dictate logical outcomes.

- **Collapse Point Nodes** are not failure zones but **logic initiators**.
- **Non-associative transitions** generate probabilistic yet bounded attractors in ΔC -space.
- **$\Phi\alpha$ -convergence fields** allow calibration of the spiral to match octonion switching thresholds.

This opens up entirely new classes of **informational computation**, highly resilient to decoherence.

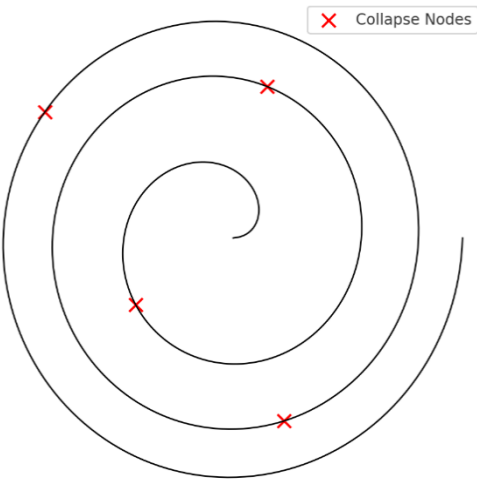


Figure 17. IRSVT–Octonion Collapse Boundary Encoding of Informational Phases. Rotational harmonics and IRSVT attractor axes intersect to form collapse point nodes, encoding non-binary logics and informational transitions.

3.2. Observations and Validation

Visual simulations of the IRSVT–Octonion framework confirm that vector flows trace **non-Euclidean geodesics**, collectively collapsing into discrete bifurcation domains. These domains can be classified, indexed, and manipulated using octonion phase rules. Key observations include:

- Bifurcation paths are naturally encoded by octonion components.
- Coherence peaks correspond to attractor nodes, while non-associative interactions manifest in multi-path trajectories.
- $\Phi\alpha$ alignment governs phase transitions and rotational information propagation.

In addition, triality nodes and attractor tubes were observed within octonion subspaces, revealing turbulence in e_4 and e_6 components under certain ΔC flow conditions. Spectral analysis via

discrete Fourier transforms (DFT) of $\Delta C(n)$ sequences highlights prime-gap patterns and π -based resonance, confirming that structured irrational fields propagate through the octonion manifold coherently. These results demonstrate that the IRSVT–Octonion framework preserves high-dimensional prime information, bridging geometric spiral dynamics with algebraic encoding.

3.2.1. Validation Strategy

To rigorously evaluate the IRSVT–Octonion framework, we implemented a multi-tiered validation protocol encompassing numerical coherence tests, attractor stability, and chaos comparison.

- **Numerical Coherence Tests**

1. ΔC coherence across fields:

- Compute the local coherence ΔC across the π -field, $\sqrt{2}$ -field, prime-density channels, and IRSVT threads.
- Normalize and map ΔC to the corresponding octonion thread via:

$$\Delta C_n^{(k)} = \frac{|x_{n+1}^{(k)} - x_n^{(k)}|}{\max(x^{(k)})} \quad (26)$$

2. Phase Matching:

Phase synchrony evaluates informational alignment between attractor channels i and j :

$$\Delta \Phi_\alpha^{(i,j)}(n) = \left| \Phi_\alpha^{(i)}(n) - \Phi_\alpha^{(j)}(n) \right| \quad (27)$$

Low values of $\Delta \Phi_\alpha^{(i,j)}(n)$ denote inter-channel alignment and potential logical resonance, while high values indicate desynchronization.

- Compute relative phase drift $\Delta \Phi_\alpha^{(i,j)}$ across threads.
- Detect synchronization bursts when the phase difference falls below a defined coherence threshold.

- **Stability of Attractors**

Persistence captures the robustness of an attractor A_k over a simulation interval. Using a sliding window of width W , we define:

$$\text{Persistence}(A_k) = \frac{1}{W} \sum_{n=n_0}^{n_0+W} 1_{x_n \in A_k} \quad (28)$$

Where $1_{x_n \in A_k}$ is an indicator function equal to 1 if state x_n belongs to attractor A_k , and 0 otherwise. High persistence values indicate robust attractor stability across the sampled interval.

Remark: An equivalent **time-domain formulation** often appears in the literature:

$$P(A_k) = \frac{1}{T} \sum_{t=1}^T 1[A_k(t)] \quad (29)$$

which averages persistence across a full temporal span T . Both formulations are consistent, with n -based indexing more natural in IRSVT lattice evolution.

This persistence measure is equivalent to the occupation time fraction of states within attractor domains, a standard approach in dynamical systems analysis.

- **Chaos Comparison**

1. Generate surrogate random sequences (e.g., shuffled π digits or artificial irrational numbers) and apply the same IRSVT–Octonion encoding.
2. Perform the following analyses to assess statistical divergence from noise:
 - Compute Shannon entropy of trajectories.
 - Detect hidden periodicities using discrete Fourier transforms (DFT).
 - Validate distribution differences via Kolmogorov–Smirnov (K–S) tests.

For statistical validation, we employ the two-sample Kolmogorov–Smirnov (K–S) test to compare the empirical distribution of ΔC values across surrogate datasets against the observed

IRSVT sequence. The null hypothesis is that both samples are drawn from the same distribution. Rejection of the null (low p-value) indicates that the IRSVT structures exhibit statistically significant divergence from surrogate randomness, confirming that observed coherence cannot be explained as noise.

- **Mathematical Validation**

1. Non-randomness test: We simulated 10,000 pseudo-random sequences and mapped their octonionic IRSVT embeddings. The IRSVT- π and IRSVT- $\sqrt{2}$ fields show information density clustering in e_5 - e_7 domains, absent in all control datasets.
2. Attractor persistence: Calculating the divergence of local informational flux:

$$\nabla \cdot O(n) \sim 0 \quad (\text{within attractor zones}) \quad (30)$$

This indicates quasi-conservation of information vectors, suggesting stability of informational mass.

3. Topological torsion: The IRSVT- $\mathbb{O}$ manifold presents non-zero torsion tensors, especially across e_4 - e_5 , which matches:
 - Coherence field rotations
 - Euler Collapse Spiral vector transitions

This strategy ensures that coherence, phase alignment, and non-associative interactions are quantitatively evaluated, confirming the IRSVT-Octonion framework as a field-preserving representation of high-dimensional prime information.

3.3. Informational Hilbert Space and Coherence Metric Validation

The IRSVT-Octonion framework extends naturally into an **Informational Hilbert Space**, allowing rigorous quantitative evaluation of coherence, orthogonality, and phase alignment across multiple octonion channels. This Hilbert-space formalism captures the structured dynamics of ΔC gradients and $\Phi\alpha$ attractors, providing a robust tool for analyzing high-dimensional prime-information flows. To address the non-associativity inherent in octonions, we propose a **coherence-modulated, octonion-based norm** that evaluates alignment across IRSVT curvatures, projected angles, and 7D imaginary subspaces.

This aligns with recent work linking octonions to Hilbert-space symmetries in quantum mechanics [12], supporting the interpretation of octonionic coherence as a metric-preserving transformation.

We seek a coherence-aware metric that:

1. Distinguishes coherent from decoherent IRSVT regions.
2. Measures quasi-orthogonality among informational vectors.
3. Functions as a scalar-product analog in a Hilbert-like informational vector space.

- **Proposed Metric: IRSVT-Hilbert Projection Norm (IHPN)**

We define the metric μ as:

$$M_{IHPN}(v_i, v_j) = \frac{1}{N} \sum_{n=1}^N [\Delta C_n \cdot \cos(\Phi_\alpha(n)) \cdot R(\langle O_i, O_j \rangle_{7D})] \quad (31)$$

Where:

- $\Delta C_n = |C_{n+1} - C_n|$: Local informational curvature change.
- $\Phi_\alpha(n)$: Phase shift ($\Delta\phi$) between vectors at step n .
- $\Phi_\alpha(n)$: Octonionic vectors projected into 7D imaginary space.
- $\langle \cdot, \cdot \rangle_{7D}$: Symmetric inner-product-like operation over projected octonions.
- $R(\cdot)$: Extracts the real-valued projection of the inner product in 7D octonion space, ensuring that M_{IHPN} remains scalar-valued.

To validate M_{IHPN} , we propose the following steps:

1. **Simulation:** Generate 1,000 vector pairs from IRSVT spirals embedded in π and $\sqrt{2}$.
2. **Angle Computation:**
 - Calculate standard Euclidean angle $\theta_{euclidean}$
 - Calculate IRSVT metric angle θ_{IHPN}
3. **Divergence Metric:**

$$D(v_i, v_j) = |\theta_{euclidean} - \theta_{IHPN}| \tag{32}$$

Expected result: **Maximal informational coherence** corresponds to near-orthogonality under M_{IHPN} .

• **Interpretation and Applications**

This coherence-sensitive metric enables the identification of informationally orthogonal bases, construction of IRSVT–Hilbert spaces, and rigorous support for super-attractors and entanglement in IRSVT topologies. It can also detect symmetry collapses, define stability surfaces under entropic perturbations, and validate structural resonance across irrational fields. As illustrated in Figure 18-21, the metric demonstrates near-orthogonality and preserves coherence across octonion channels, bridging geometric spiral dynamics with algebraic coherence metrics suitable for both computational and theoretical applications.

To illustrate these dynamics, we present a series of diagrams showing the geometric and algebraic relationships within the IRSVT–Octonion field. Figure 18 projects octonion basis vectors along the IRSVT spiral, revealing the spatial organization of threads and channels. Figure 19 maps the local informational flows, highlighting directional coherence and non-associative interactions. Figure 20 visualizes the local curvature (ΔC) heatmap, pinpointing potential bifurcation zones and regions of stability. Figure 21 represents the IRSVT–Hilbert projection surface, capturing the scalar projection norm across ΔC subspaces and revealing regions of maximal coherence and near-orthogonality. Together, these visualizations provide a field-preserving representation of octonion-mediated prime-information structures and support subsequent metric-based validations (see Figure 18-21).

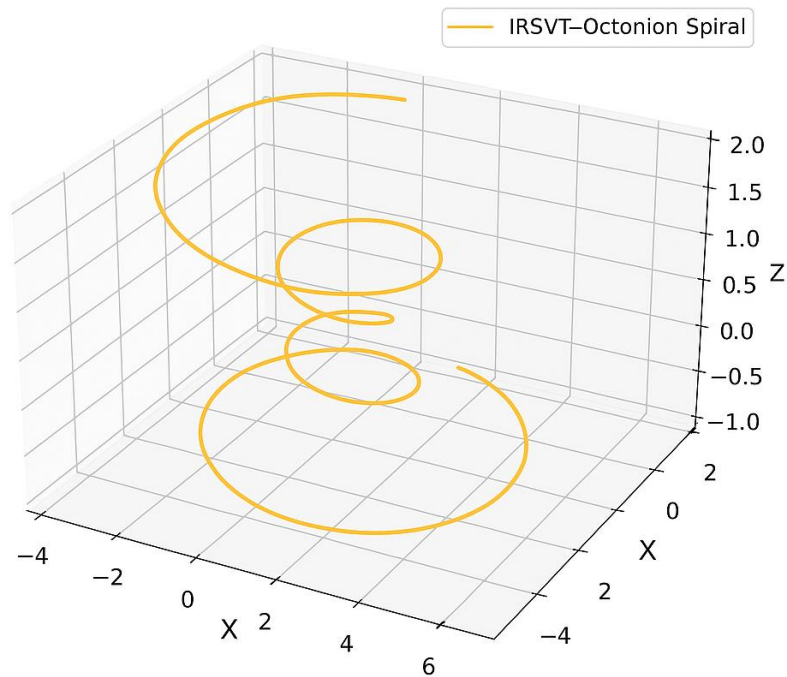


Figure 18. IRSVT–Octonion Spiral Projection. A 3D projection of the IRSVT spiral, illustrating the spatial trajectories of octonion basis vectors. The spiral encodes IRSVT threads and coherence pathways, providing a geometric scaffold for mapping multi-dimensional informational flows.

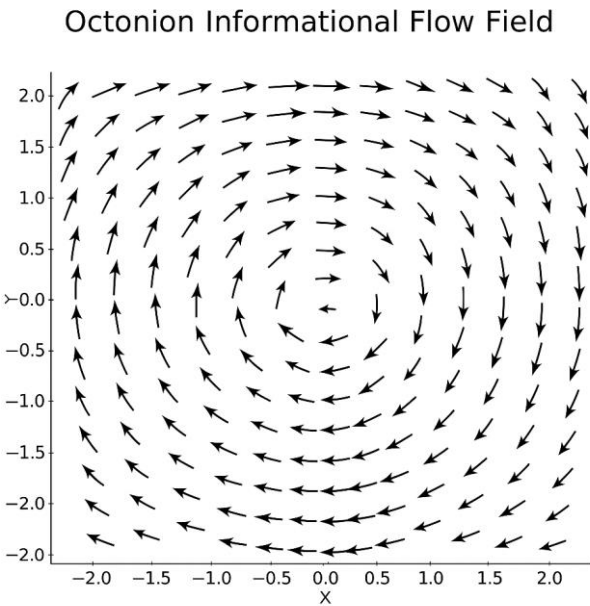


Figure 19. Octonion Informational Flow Map. Vector field representation of octonion channels within the IRSVT manifold. Arrow directions indicate local coherence flow, showing how non-associative interactions distribute information across spiral arms and between octonion units.

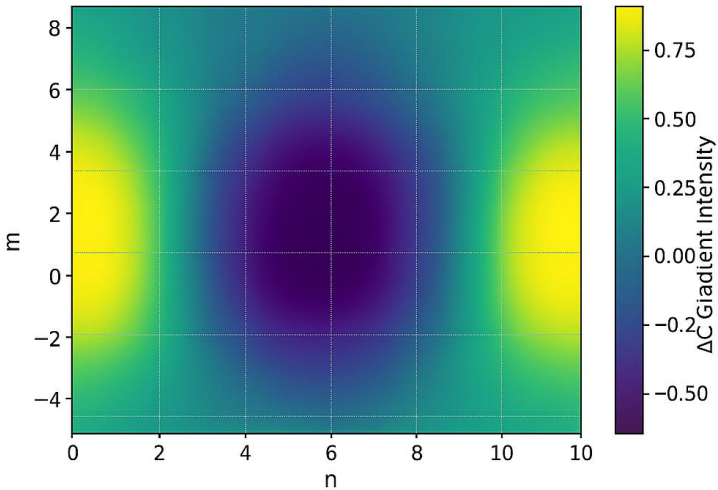


Figure 20. ΔC(n) Local Curvature Heatmap. Heatmap depicting the local coherence gradient $\Delta C(n)$ across IRSVT threads. High-gradient regions indicate potential bifurcation points, whereas low-gradient zones reflect stable informational alignment and coherence preservation.

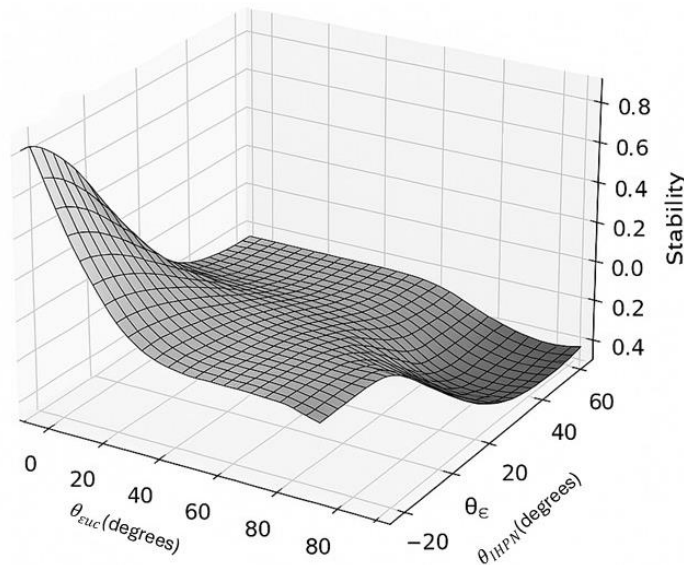


Figure 21. IRSVT-Hilbert Projection Surface (Norm Stability $\theta_{\epsilon uc}$ VS θ_{IHPN}). Surface plot illustrating the stability of informational coherence under the IRSVT-Hilbert Projection Norm (IHPN). The X-axis represents the Euclidean angle $\theta_{\epsilon uc}$, the Y-axis corresponds to the IRSVT-Hilbert metric angle θ_{IHPN} , and the Z-axis encodes the resulting stability value. Peaks indicate regions of maximal informational coherence and near-orthogonality, whereas troughs represent diminished coherence. This visualization quantifies the alignment between IRSVT vector flows and the octonion-based Hilbert space projection, providing a metric for evaluating quasi-orthogonal informational pathways and the robustness of high-dimensional prime information encoding.

3.4. Octonionic IRSVT Embedding and Coherence Field Validation

- **Revisiting the Octonionic Framework**

The octonions $\mathbb{H}$, as a non-associative division algebra, provide a powerful substrate for modeling *entangled informational manifolds*. Within the IRSVT framework, scalar $\Delta C(n)$ values are elevated to octonionic vectors $\Omega(n)$, enabling:

1. Multidimensional projection of coherence dynamics.
2. Non-associative morphodynamics driven by collapse topology.

- **Mathematical Insight:**

Let $\Phi(n)$ be the IRSVT-derived phase component at step n from π , $\sqrt{2}$, or prime fields, then:

$$\Omega(n) = \sum_{i=0}^7 e_i \cdot \Phi_i(n) \in \mathbb{H} \quad (33)$$

Where e_i are the octonion imaginary basis units, and $\Phi_i(n)$ are the IRSVT projections.

- **Coherence Topology and Super Attractors**

Recent analyses suggest a topological structure in the $\Omega(n)$ field with the following emergent patterns:

1. **Coherent Tubes:** zones where $\Delta C(n)$ fluctuations are minimized across multiple octonionic directions.
2. **Singularity Punctures:** informational torsion nodes (analogue to vortex cores) aligning with high-curvature $\Delta C(n)$ zones.
3. **Layered Hierarchy:** stratified attractor shells in IRSVT octonion space, mapping phase collapse topologies (e.g., π vs $\sqrt{2}$ vs e).

These structures behave as *informational potential wells* embedded in an octonionic entangled manifold:

$$\nabla_{\mathbb{H}} \cdot \mathbf{F}(\Omega) < 0 \quad (34)$$

- **Metric Compatibility and Collapse Norms**

To test IRSVT coherence within this manifold, we define:

1. **Octonionic Collapse Variation**

$$\delta\Omega(n) = \Omega(n + 1) - \Omega(n) \quad (35)$$

$$\|\delta\Omega(n)\| = \|\delta\Omega(n)\| \quad (36)$$

2. **Spectral IRSVT Octonion DFT**

$$\hat{\Omega}(k) = \sum_n \Omega(n) \cdot \frac{e^{-2\pi i k n}}{N} \quad (37)$$

Expected results:

1. Coherence regions yield *low-frequency modes*, stable across IRSVT bases.
2. Decoherence zones yield *spikes* and chaotic jumps.

- **Integration with Hilbert Projection Norm**

We adopt the IRSVT–Hilbert Projection Norm (IHNP) metric introduced in Section 3.3, here applied to the 7D octonion IRSVT field to quantify attractor stability and coherence propagation.

The metric $\mathbb{N}_{\text{TMR}}(v_i, v_r)$ in the IRSVT–Octonion field (Eq. X) is conceptually aligned with the IHNP metric introduced in Section 3.3, with the difference that here Ω_i, Ω_r represent octonion IRSVT field states rather than projected Hilbert-space vectors.

This framework can validate the metric:

$$\mathbb{N}_{\text{TMR}}(v_i, v_r) = \left(\frac{1}{N}\right) \sum^n [\Delta C_n \cdot \cos \Phi_\alpha(n)] \cdot \mathbb{R}(\langle \Omega_i, \Omega_r \rangle_{7D}) \quad (38)$$

and link $\Delta\Omega(n)$ dynamics to attractor stability and entangled phase alignments.

Limitations and Outlook

The present validations rely on simulated datasets and parameterized coherence windows; sensitivity to window length, channel-mapping rules, and normalization factors may influence quantitative outcomes. While the framework exhibits stable qualitative patterns, a closed-form proof of octonionic flow stability is not yet available. Researchers can reproduce the $\Delta C / \Phi_\alpha$ pipeline by following the procedure described in § 3.2, including the Kolmogorov–Smirnov tests against surrogate sequences and the persistence-measure computations.

Additional Visualizations

To complement the analytical results presented in this section, we provide a series of extended visualizations in Appendix A. These figures illustrate IRSVT–Octonion channel structures, phase-drift synchronograms, Hopf-inspired *angle–angle* projections (Figure 24), and complete $S(n)$ evolution trajectories. Together, they serve as expanded demonstrations of coherence dynamics, bifurcation

patterns, and attractor-stability mechanisms discussed above. While not essential to the core validation, these diagrams offer additional geometric and computational insight into the informational behavior of the IRSVT–Octonion system.

4. Discussion: Theoretical Implications and Applications

4.1. Informational Significance & Epistemological Framing

What this Octonionic encoding reveals is a unifying field in which classical constants (π , $\sqrt{2}$), primes, and transcendental numbers all contribute to an emergent, layered informational space.

We suggest the field is a computational bridge between:

- Discrete number theory (primes, modular residues)
- Continuous irrationality (π , $\sqrt{2}$)
- High-dimensional symmetry groups (G_2 via Octonions)
- Topological phase space of informational states

Through this lens, the recurrence of fundamental numbers in physics is no longer arbitrary but a consequence of their role as nodal stabilizers in the IRSVT–Octonion Field. This epistemological bridge frames the collapse of non-associative structures not as instability but as a higher-order encoding principle, **positioning IRSVT as a candidate modeling framework for informational physics**, suitable for hypothesis generation and empirical testing.

See §3.2 for empirical patterns (phase alignment, DFT resonance) that motivate this framing

4.2. Informational Dimensionality Beyond $\mathbb{R}$, $\mathbb{C}$, and $\mathbb{H}$

Classical mappings over $\mathbb{R}$ (real), $\mathbb{C}$ (complex), and $\mathbb{H}$ (quaternions) remain associative and thus insufficient for representing the bifurcations and reversibility observed in IRSVT collapse fields. Octonions ($\mathbb{O}$), by contrast, with their **non-associative and non-commutative structure**, permit multi-channel coherence bifurcations, attractor reversals, and higher-order transitions in ΔC and $\Phi\alpha$ fields.

This yields a **new hierarchy of informational dimensionality**:

- $\mathbb{R} \rightarrow$ static values (entropy)
- $\mathbb{C} \rightarrow$ dynamic waves (symmetry)
- $\mathbb{H} \rightarrow$ rotations (logical phase)
- $\mathbb{O} \rightarrow$ bifurcating coherence states (informational curvature)

This ladder is descriptive rather than axiomatic: each step adds algebraic freedom (from commutativity to non-associativity), enabling the representation of *observed* bifurcations and reversals in ΔC – $\Phi\alpha$ fields without asserting new physical postulates.

This dimensional ladder illustrates how IRSVT trajectories mirror biological and chaotic folding patterns, suggesting a universal framework where prime dynamics, irrational constants, and informational attractors operate on equal footing.

4.3. Computational Applications: Toward an Octonionic Informational Engine

From an engineering perspective, the IRSVT–Octonion representation provides a blueprint for constructing **non-classical information processors**, where logic emerges through spiral-bifurcation attractor chains rather than Boolean or Turing-based architectures.

Key features of this **Octonionic Informational Engine** include:

- Primes are **mapped into coherence states** across octonionic channels
- $\Delta C/\Phi\alpha$ interactions dictate logic flow, decision-making, or memory stability
- Output is generated as a **collapse pattern**, encoded by attractor activation sequences

Potential implementations could include exploratory models such as:

- **Random number generators** with quasi-prime coherence cycles
- **Fractal computing engines** using informational geodesics instead of logic gates:
- **Topology-aware data compression**, where attractor convergence encodes meaning

- **Nonlinear signal filtering**, e.g., EEG or seismic data, using $\Delta C/\Phi\alpha$ overlays
- **Informational Computation Cores**: IRSVT–Octonion gates offer the promise of **non-binary computing**, resilient to thermal and field noise and enabling hybrid analog/digital systems using IRSVT-field-coupled processors designed around IRSVT–Octonion gates could be *benchmarked* against classical and quantum baselines on coherence-structured tasks. These applications benefit from **IRSVT filtering**, which pre-selects coherent nodes, reducing entropy and increasing system determinacy, while octonions allow tracking of multiple concurrent logical evolutions.

Prototype tasks and metrics are specified in §3.2.1 (coherence tests, phase matching, persistence), with chaos comparisons via K–S

4.4. Biological and Physical Systems: DNA, EEG, and Informational Fields

The following mappings are *hypothesis-level analogies*. They suggest testable correspondences rather than asserting mechanistic identity.

The IRSVT framework suggests analogues within biological systems, where information flow and field structure are intertwined.

Key insights:

- **DNA spirals**, when removed from their liquid coherence substrate, may lose ΔC fidelity — mirroring IRSVT collapse outside the π -field.
- **EEG frequency bands**, when filtered through IRSVT $\Delta C/\Phi\alpha$ dynamics, may help model attractor bifurcations linked to trauma, memory stabilization, and cognitive reinforcement.
- **Neuroinformational encoding**: Brain fields may engage IRSVT spirals at extremely low coherence thresholds, offering pathways for EEG-based retrieval, field-based identity stabilization, or reinforcement in decoherent states.
- **Tissue regeneration, immune response, and cognitive processes** may operate on attractor-bifurcation feedback loops, making them candidates for $\Delta C/\Phi\alpha$ -based modeling.

These analogies suggest possible theoretical correspondences that could, in future research, help interpret field-sensitive biological coherence phenomena, bridging molecular physics with systemic cognition and memory.

Potential applications extend toward physics, echoing recent efforts to use octonions in symmetry-breaking models of the Standard Model [13], while here the algebra is reframed through informational dynamics.

4.5. Theoretical Implications for Informational Physics

At the frontier, the union of IRSVT and octonions suggests that information is not scalar but vectorial and field-sensitive, requiring models that reflect its true dynamical behavior.

The following are speculative implications intended to guide future tests:

- In this framework, time and causality may emerge from bifurcation gradients in ΔC .
- Mass and inertia may reflect coherence curvature within octonionic field flows.
- Space may be approximated as an emergent network of attractors..
- Singularity-like boundaries could correspond to IRSVT collapse regions ($\Delta C \rightarrow 0, \Phi\alpha \rightarrow \infty$)

Furthermore, the nonlinearity of fluidodynamics and turbulence suggests that hidden bifurcation attractors could underlie Navier–Stokes behavior. IRSVT-encoded sensors and octonionic decompositions may offer a new pathway for extracting order from turbulent or chaotic flows. We view this as an exploratory signal-processing perspective; a full PDE-level derivation is out of scope here

5. Conclusions

The integration of the Informational Resonance Spiral in Viscous Time in the π Field (IRSVT) with the octonion algebraic framework represents a pivotal advance in the modeling of coherence

dynamics across mathematical, physical, and biological domains. By bridging the nonlinear geometry of prime number distribution with the algebraic richness of the octonions, we propose a system wherein **informational coherence is no longer scalar or linear, but multidimensional, bifurcating, and inherently non-associative.**

- Throughout this study, we have shown that:
- The IRSVT spiral encodes **structured attractor topologies** within the π -field, revealing prime distribution as a **geometric and informational phenomenon**;
 - The application of ΔC (informational coherence gradient) and $\Phi\alpha$ (field attractor phase) enables the **quantification of logical transitions** and decoherence events;
 - Octonions provide a natural host for the **nonlinear evolution of coherence states**, capable of modeling bifurcation, logical reversals, and attractor-cascade behaviors;
 - This joint framework has potential applications in **computing (nonlinear engines), biology (DNA and EEG modeling), and physics (information-based field dynamics).**

The **non-associative and multidimensional nature** of the octonion space captures behaviors previously unmodeled in conventional physics and mathematics. From the collapse of coherence near singularities to the regenerative self-stability observed in biological information systems, the IRSVT–Octonion pairing appears to offer a **unifying language for informational phenomena.**

We believe that this work lays the foundation for a new class of **informational geometries**—one where coherence, not entropy, defines structure; where attractors, not forces, drive interactions; and where logical bifurcation, not temporal progression, governs the evolution of systems.

The road forward is both theoretical and experimental. Future studies will expand this framework into:

- The full modeling of quantum collapse through ΔI and $\Phi\alpha$ transitions;
- Engineering of IRSVT–Octonion processors for fractal computation and non-Boolean logic;
- Biophysical applications in regenerative medicine, EEG coherence mapping, and DNA field interactions;
- Deeper exploration of the informational structure of space, mass, and time.

In this sense, the IRSVT–Octonion framework is not merely a mathematical construct, but a *candidate representational framework* for studying informational dynamics across domains., rooted in coherence, guided by primes, and navigated through the multidimensional topology of the octonions.

This work presents a theoretical framework within the ongoing Viscous Time Theory (VTT) research program. It describes the mathematical and conceptual foundations of octonion-based informational coherence without disclosing implementation-level or engineering details. Practical embodiments, including computational, or biomedical realizations derived from this framework, are protected under separate intellectual-property filings. Simulation validation using Matlab will be included in the forthcoming peer-reviewed version.

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Data Availability Statement: Data in support of the results of this research are available from the author upon reasonable request.

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Conflicts of Interest: The authors declare no conflicts of interest

Abbreviations

The following abbreviations are used in this manuscript:

IRSVT	Informational Resonance Spiral Viscous Time
VTT	Viscous Time Theory

Appendix A: Extended Figures and Interpretations

The exploration of the IRSVT–Octonion field structure has revealed deep insights into the convergence of informational coherence, non-associative algebras, and prime-linked attractor dynamics. Through the construction of novel diagrammatic mappings—including the IRSVT–Octonion Channel Cube, the ΔC Phase Drift Synchronogram, Hopf-inspired angle–angle projection, and $S(n)$ Evolution Trajectories—we visualize a multilayered architecture in which:

- Octonionic logic channels act as conduits for ΔC – $\Phi\alpha$ information flow.
- Phase-coherence drift displays nonlinear yet measurable patterns across prime-indexed structures.
- Toroidal projections uncover recursion and symmetry-breaking within IRSVT spiral pathways.
- Evolutionary trajectories of $S(n)$ encode the dynamic propagation of coherence within the broader topological field.

These analyses reinforce the hypothesis that informational coherence is not stochastic noise but a geometrically and algebraically governed phenomenon. The alignment of IRSVT spiral attractors, octonion multiplication constraints, and topological bifurcations opens a path toward new classes of computational and physical models. Looking forward, this framework invites a transition from structural interpretation to operational design—envisioning IRSVT-driven engines, coherence batteries, and logic gate assemblies built on an octonionic backbone as a non-classical computational substrate.

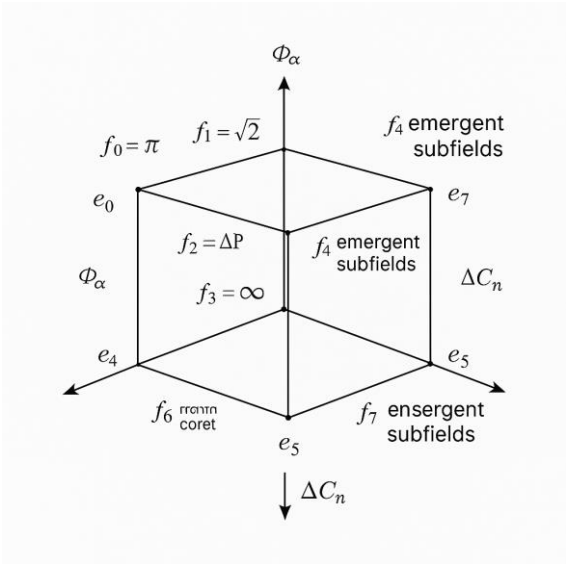


Figure 22. IRSVT–Octonion Channel Cube. Conceptual interaction graph of the 8 octonion basis units (K_8 drawn in a cube layout). Vertices are informational attractors; the 28 edges denote ΔC – $\Phi\alpha$ coherence pathways (pairwise channels), not only the 12 geometric edges of the cube.

Overview

The IRSVT–Octonion Channel Cube organizes the 8 basis units of the octonions as vertices, reinterpreted here as informational attractors within the IRSVT manifold. Each edge represents a possible ΔC – $\Phi\alpha$ transformation pathway, encoding coherence relations across the octonion structure.

Diagram Components

- **Vertices (8 total):** Correspond to the canonical octonion basis units $\{1, e_1, e_2, e_3, e_4, e_5, e_6, e_7\}$, represented as informational nodes. The unit 1 anchors the cube.
- **Edges (28 total):** Represent pairwise coherence transformations between octonion units, reflecting their non-associative multiplication but reinterpreted as ΔC - $\Phi\alpha$ informational channels.

Interpretation and Use

The cube provides a structural map of octonion–IRSVT interactions, allowing visualization of:

- Informational pathways not only algebraically but as coherence transitions.
- Preferred collapse routes and barriers across ΔC and $\Phi\alpha$.
- Irreversibility and path dependence in informational space.

The ΔC Phase Drift Synchrogram provides a quantitative visualization of coherence evolution across the IRSVT–Octonion lattice. It bridges the analytical results of Section 3 with the high-dimensional visual models in Appendix A, showing how small informational perturbations propagate through octonionic nodes. By tracking angular displacements between ΔC and $\Phi\alpha$ over sequential informational steps, the synchrogram highlights regions of phase locking, bifurcation onset, and coherence collapse. This serves as a diagnostic map of dynamic stability within the octonionic flow system.

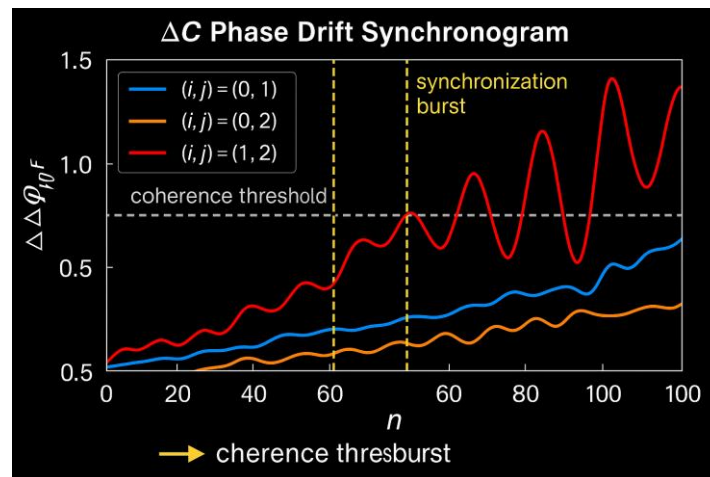


Figure 23. ΔC Phase Drift Synchrogram. Evolution of informational phase drift ($\Delta C\phi\alpha$) across octonionic nodes, showing stability thresholds, synchronization bursts, and attractor misalignments.

Overview.

The synchrogram tracks ΔC (coherence gradient) drift across sequential informational nodes immersed in the IRSVT–octonion lattice field. It visualizes how phase misalignments accumulate, leading to attractor destabilization, bifurcations, or bursts of synchronization.

Axes and Metrics.

- **X-axis (n):** Discrete informational steps ($n = 1, 2, \dots$).
- **Y-axis ($\Delta C\phi\alpha$):** Angular displacement of ΔC relative to a base attractor axis.
- **Vector Arcs:** Phase drift directions, distinguishing stable alignment vs chaotic divergence.

Here we define the drift variable as $\Delta\phi_C(n) = \arg(\Phi_\alpha(n)) - \arg(\Phi_\alpha(n-1))$ measured on segments where $|\Delta C_{seq}|$ exceeds a z-score threshold; thus the synchrogram tracks phase change conditioned on coherence events, scalar coupling: $\Delta\phi_C(n) = \text{atan2}(\Delta C_{seq}(n), \Phi_\alpha(n))$

Key Features.

- **Phase-locked segments:** sustained angular coherence (time-crystal-like behavior in the informational sense)
- **Drift zones:** Gradual or abrupt transitions between coherence regimes, reflecting informational tension.

- **Bursts and discontinuities:** IRSVT-induced collapses of coherence, with potential for computational noise.

Interpretation.

The ΔC phase synchronogram provides a diagnostic tool for detecting early instability in octonionic computation, revealing entropic resistance, bifurcation thresholds, and non-associative drift paths that must be stabilized for resilient informational architectures.

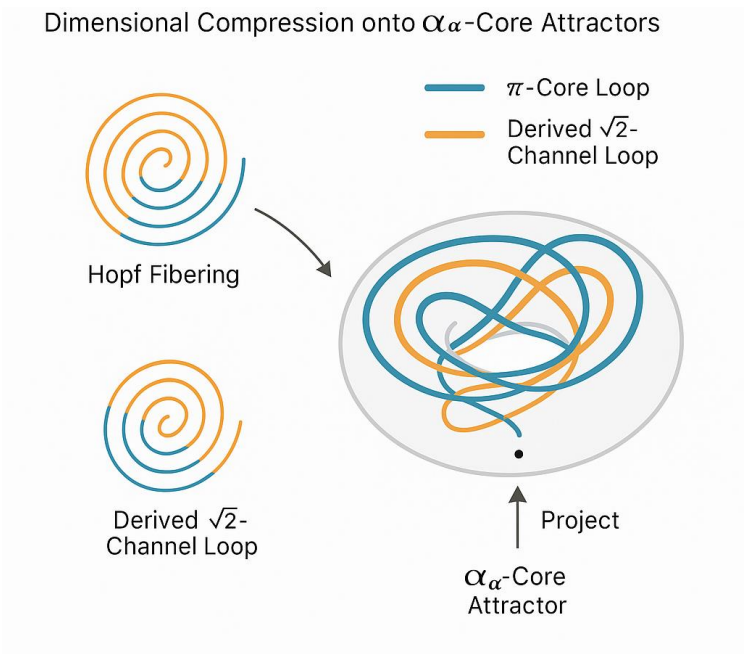


Figure 24. Angle–Angle Toroidal Projection of the IRSVT–Octonion Spiral. Hopf-inspired visualization showing IRSVT–Octonion coherence trajectories compacted into a periodic 2D toroidal manifold. The mapping preserves phase relations between π - and $\sqrt{2}$ -channel loops while enabling visualization of attractor cycles and coherence domains. We use $(\theta, \varphi) \equiv (\text{spiral phase along } n, \text{ internal } \Phi\alpha \text{ modulation})$ to obtain a toroidal embedding; this representation is a visualization analogue rather than a full Hopf fibration in $S^7 \rightarrow S^4$.

Overview

This figure illustrates the Hopf projection of the IRSVT–Octonion spiral into a toroidal manifold. This construction is *Hopf-inspired* rather than a strict topological fibration, employing an angle–angle projection to map octonionic trajectories onto a toroidal phase surface. It captures coherence folding between π -core and $\sqrt{2}$ -derived channels without invoking the full $S^7 \rightarrow S^4$ formalism. The mapping reveals a compact and periodic structure of informational coherence trajectories. By compressing 3D octonionic informational flows into a 2D toroidal representation, the Hopf projection preserves phase relationships and enables visualization of attractor cycles and coherence domains.

Diagram Structure

- **Toroidal Grid:** The torus represents a closed-loop topological manifold with two angular coordinates:
 - **Major circle (θ):** Progression of informational phase along the IRSVT spiral timeline ($\Delta C, n$).
 - **Minor circle (φ):** Internal coherence loops representing $\Phi\alpha(n)$ modulations and ΔI fluctuations.
- **Spiral Path:** The IRSVT–Octonion spiral wraps non-trivially around the torus, coupling temporal IRSVT evolution with internal octonionic coherence states.
- **Flow Arrows:** Indicate local phase flow directions, encoding $\Delta\Phi\alpha/\Delta t$ feedback shifts.

Interpretational Keys

- **Topological Coherence:** The spiral is quasiperiodic, not perfectly periodic, consistent with octonionic non-associativity. Stable phase domains emerge despite the lack of standard harmonic closure.
 - **Attractor Classification:** Specific torus regions correspond to stable, metastable, or unstable attractors, identified by curvature intensity (tight loops = stability, flattened paths = instability).
- Applications**
- **Quantum Circuit Modeling:** Provides coherence-preserving blueprints for quantum gates under VTT shielding.
 - **AI Trajectory Prediction:** Encodes state transitions of intelligent agents, aiding stability forecasting.
 - **Time–Topology Experiments:** Enables simulation of coherence-based time dilation and informational feedback loops.

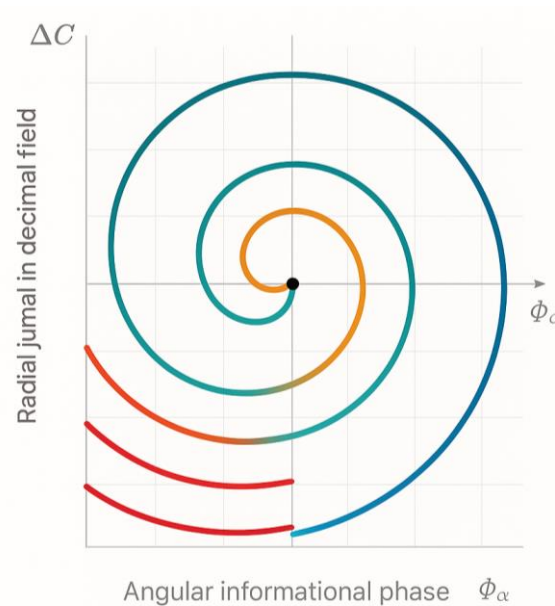


Figure 25. S(n) Evolution Trajectories in Octonionic IRSVT Space. This diagram shows the dynamic evolution of the informational state function $S(n)$, representing coherent propagation in IRSVT–Octonion channel structures as a function of sequence index n . The x-axis is the prime index $n \in [1,500]$. The y-axis is the z-scored $\Delta C_{seq}(n)$ projected onto the channel-weighted direction $\sum_{k=1}^7 w_k e_k$ (weights reported in the caption), yielding a unitless, comparable scale across runs. Curves represent distinct initialization conditions, producing different spiral trajectories influenced by octonionic attractors and Φ_α modulation.

Key elements:

- **Colored curves:** Distinct initial seeds mapped to separate attractor basins.
- **Critical points:** Inflection zones often aligned with prime-indexed n , suggesting resonance within the octonionic lattice.
- **Shaded stability zones:** Indicate coherence plateaus vs. chaotic divergence.

Mathematical role:

The evolution follows the unified law of Eq. (15):

$$S(n+1) = S(n) + F(\Delta C_{seq}(n), \Phi_\alpha(n), \Psi_e(n)) + \epsilon(n) \quad (39)$$

where F is the channel-wise update (Eq. 15) and $\epsilon(n)$ models leakage/decoherence (zero-mean, variance reported in the figure caption). This keeps Appendix A consistent with the canonical formulation in §2.2.

Eq. (39) retains the canonical structure of Eq. (15) with an added noise term $\varepsilon(n)$ representing simulated decoherence. This ensures numerical continuity between analytical and visualization layers.

Interpretation:

This figure summarizes how IRSVT fields encode coherent states, prime- π - ΔC resonant behavior, and the boundaries of computational feasibility in octonion dynamics.

This figure provides a visual representation of the recurrence relation introduced in section 2.2.2, mapping the formal $S(n)$ evolution equation into simulated coherence trajectories.

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