Fractal Vector Geometry — Signal True Always True

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Abstract

This white paper introduces a mathematical–conceptual framework for **Fractal Vector Geometry**, where geometry exists without fixed coordinates, and coherence is expressed through dynamic vector relations. The model proposes a global coherence field and an effective entropy S_{eff}, whose variations satisfy the proposed law of conservation of coherence:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0.$$

The work bridges symbolic language, information geometry, and fractal dynamics to open new avenues for physics, cosmology, computation, and metaphysics.

Contents

1 Preliminaries

This section introduces the fundamental objects of the Fractal Vector Geometry model. The goal is to clarify the minimal ingredients needed to build the coherence field, the vectorial paths, and the metric that governs dimensional transitions.

1.1 Notation and basic objects

We consider an N-dimensional coherence manifold $\mathcal{M}$, on which the fundamental degrees of freedom are not positions but *coherence vectors*. All quantities evolve according to the internal geometry of coherence rather than fixed coordinates.

- $\mathcal{M}$: the coherence manifold (a space of possible states of the Signal).
- g : the fractal metric, encoding how coherence accumulates or disperses.
- Δ_d : the dimensional jump operator, mapping local directions between layers of the manifold.
- γ : a vectorial path, i.e., a sequence of coherence vectors forming a chain.

1.2 The fundamental coherence vector v_i

The core building block of the entire theory is the **elementary coherence vector** v_i.

It is NOT:

- a velocity,
- a classical force,
- nor a position in space.

Instead, v_i represents:

> **a local tendency of information to align, stabilize, or synchronize along the i-th coherence direction of the manifold**.

More formally:

$$v_i : \mathcal{M} \longrightarrow \mathbb{R}^N$$

Each v_i contains N components because even though it is labeled by a single "direction index" i, it *lives inside an N-dimensional coherence space*. Thus, in the simulation, we only see its 2D projection— but mathematically, the vector exists in full N dimensions.

Why i? What does the index mean?

The index i does NOT represent a spatial coordinate. It represents:

> **one distinguishable mode of coherence—one way in which information can try to stay aligned.**

You can think of each v_i as a "strand" in a large multidimensional weaving pattern. Many v_i may be similar, harmonious, opposed, or orthogonal: the model allows for clusters of coherence vectors behaving collectively.

1.3 Building vectorial paths

A *vectorial path* γ is a finite sequence of coherence vectors:

$$\gamma = (v_1, v_2, \ldots, v_k).$$

These paths arise when local coherence vectors stabilize relative to each other. They represent emergent *routes of coherence flow* through the manifold.

The length of such a path, measured through the fractal metric g, is:

$$L(\gamma) \;=\; \sum_{i=1}^{k-1} \sqrt{g(\Delta_d(v_i),\, \Delta_d(v_i))}\;.$$

1.4 From local vectors to global coherence

Local coherence vectors interact through tensorial products. Each pair contributes a small "patch" of organized structure:

$$T_{ij} = v_i \otimes v_j.$$

The full coherence field is the global summation over all such patches:

$$\mathcal{C}_{\text{global}} \;=\; \sum_{\text{all pairs } (i,j)} v_i \otimes v_j.$$

This is the mathematical analogue of a **tissage fractal**: each v_i is a thread, each product $v_i \otimes v_j$ is a stitch, and the sum of all stitches forms the global coherence fabric.

1.5 Physical interpretation (summary)

- Each v_i is a **local tendency of structure**.

- Paths γ represent **stable channels of coherence flow**.
- Tensorial products encode **interactions and coupling**.
- Their summation yields the **global coherence field**.

This is the foundation on which all subsequent sections (metric, forces, transitions, conservation law...) are built.

2 Coordinate-Free Vector Geometry

In this framework, geometry is not defined by a pre-existing coordinate system. Instead, it emerges from the relations between elementary coherence vectors $\{v_i\}$ introduced in Section 1. Each v_i is an intrinsically N-dimensional object representing an elementary *direction of coherence tension* in the universal field.

The key innovation of this model is that the geometry of the space does not depend on where the system is located or how it is parameterized. It depends only on how the elementary signals relate to each other.

2.1 Vector Manifold

A **vector manifold** is defined as a collection of elementary coherence vectors $\{v_i\}$ equipped with a notion of relational tension. At any local point of the field, the system contains a finite number of possible directions of coherence propagation.

Each v_i is not a spatial arrow but an abstract object encoding how information tends to align in the i-th coherence direction. Thus, the manifold is the collection of all these local directions, stitched together by the field's internal consistency.

Formally, the manifold exists as long as the set $\{v_i\}$ spans a non-degenerate relational structure. No choice of coordinate chart is required; the geometry resides in the *pattern of relations* between the v_i themselves.

2.2 Vectorial Paths and Dimensional Jumps

A **vectorial path** is built from a sequence of coherence vectors:

$$\gamma = (v_1, v_2, \ldots, v_k).$$

Such a path represents the flow of coherence through adjacent coherence directions. The path is not spatial; it is informational and structural.

A dimensional jump occurs whenever two consecutive vectors differ strongly in their coherence orientation:

$$\Delta_d(v_i) = v_{i+1} - v_i.$$

Large $\|\Delta_d(v_i)\|$ indicate transitions between regions of distinct coherence regimes, corresponding to emergent structural changes.

These jumps generalize curvature. Instead of describing curvature of a metric on a space, we describe the curvature of the *coherence flow* itself.

2.3 Intrinsic Curvature without Coordinates

Curvature emerges from how paths deviate from equivalence under small perturbations of their coherence directions.

Given a path γ, its curvature is defined by:

$$\kappa(\gamma) \propto \sum_i \|\Delta_d(v_i)\|.$$

This expresses how strongly the coherence field bends or reorients itself along the path.

This curvature is intrinsic:

- it does not depend on any coordinate chart, - it does not require embedding in a higher-dimensional Euclidean space, - it depends only on the relational structure encoded by the set $\{v_i\}$.

Thus, the manifold's geometry is *entirely emergent*.

2.4 Local Tensor Products and Coherence Tension

Every pair (v_i, v_j) defines a local tensor product:

$$T_{ij} = v_i \otimes v_j.$$

These local tensor products encode how two coherence directions reinforce, cancel, or distort each other.

The global coherence field is then obtained by summing all local tensors over all possible vectorial paths:

$$\mathcal{C}_{\text{global}} = \sum_\gamma \sum_{i,j \in \gamma} v_i \otimes v_j.$$

This defines a universal "weaving" of coherence tensions, where each segment of each path contributes a strand to the global fabric.

In this view:

- local tensors are *threads*, - vectorial paths are *stitches*, - and the global coherence field is the *finished fabric*.

This formulation is essential in establishing the conservation law:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0,$$

where changes in coherence must be balanced by changes in the system's effective entropy.

3 Fractal Metric Tensor

The metric in this framework is not defined on a classical manifold. Instead, it emerges from the internal structure of the coherence field. Its role is to quantify how the elementary coherence vectors $\{v_i\}$ stretch, compress, or reorient relative to each other.

In this sense, the metric is not geometric in the classical sense: it measures *coherence tension*, not spatial distance.

3.1 Local Metric Definition

For any coherence vector v_i, we define its local metric contribution through:

$$g(v_i, v_i) = \|v_i\|^2.$$

This expresses how much coherence is locally concentrated along the i-th direction. A high value indicates strong alignment of informational flow in that direction; a low value indicates diffuse or unstable coherence.

The metric is therefore a measure of the "strength" or "density" of coherence in a given elementary direction.

3.2 Metric over a Path

Given a vectorial path

$$\gamma = (v_1, v_2, \ldots, v_k),$$

its length is defined by:

$$L(\gamma) = \sum_{i=1}^{k-1} \sqrt{g(\Delta_d(v_i), \Delta_d(v_i))},$$

where

$$\Delta_d(v_i) = v_{i+1} - v_i.$$

The length of a path measures how much the coherence structure bends or reconfigures as one moves from one elementary direction to the next.

Large values of $L(\gamma)$ indicate that the signal traverses regions of high structural variation; small values indicate stable coherence terrain.

3.3 Curvature of Coherence

The curvature associated with a path γ is defined as the accumulation of orientation shifts between successive vectors:

$$\kappa(\gamma) = \sum_{i=1}^{k-1} \|\Delta_d(v_i)\|.$$

This definition is purely internal to the coherence field:

- It does not rely on embedding the system in any external geometry.
- It does not assume spatial curvature.
- It reflects only how coherence tensions reorganize themselves.

Thus, curvature is a measure of how coherence moves across "informational folds" of the universal field.

3.4 Emergent Fractal Metric

At larger scales, the total metric is obtained by aggregating tension across all possible coherence paths:

$$g_{\text{fractal}} = \sum_{\gamma} L(\gamma).$$

This makes the metric fractal in nature: it reflects contributions from all scales of coherence, from the most local to the most extended.

This construction mirrors the self-similar nature of the field: coherence reorganizes itself at all scales according to the same principles.

3.5 Relation to the Global Coherence Field

The fractal metric is directly tied to the global tensor field introduced in Section 2:

$$\mathcal{C}_{\text{global}} = \sum_{\gamma} \sum_{i,j\in\gamma} v_i \otimes v_j.$$

Where the global tensor encodes the *structure* of coherence, the fractal metric measures its *resistance to deformation*.

We then obtain the fundamental law of the model:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0,$$

where $\Delta\mathcal{C}$ is expressed through variations in the global tensor field, and S_{eff} is the effective entropy measuring the cost of losing coherence.

This closes the conceptual loop between:

- the metric (local coherence tension),
- the tensor field (global coherence weaving),
- and the invariant (coherence–entropy conservation).

The fractal metric is therefore not an optional construct—it is the bridge that translates local informational dynamics into global structural behavior.

4 Dimensional Forces and Emergent Matter

In this section, we interpret the internal geometry of the coherence field as giving rise to *forces* and, ultimately, to the phenomenon that appears to us as *matter*. The key idea is that forces do not need to be postulated separately: they emerge from the way coherence tries to maintain itself across the fractal manifold.

4.1 From coherence gradients to effective forces

Let $C(x,t)$ denote the local coherence vector obtained from the contributions of the elementary vectors v_i at point x and time t. We define the coherence density

$$c(x,t) := \|C(x,t)\|^2,$$

and, as in later sections, the global coherence functional

$$\mathcal{C}(t) := \int c(x,t)\,\mathrm{d}\mu(x).$$

Whenever $c(x,t)$ varies in space, there exists a *coherence gradient*

$$\nabla c(x,t),$$

which expresses how strongly coherence 'pulls' information toward regions of higher or lower organization.

We interpret this gradient as an *effective force*:

$$F_{\mathsf{coh}}(x,t) \propto -\nabla c(x,t).$$

The minus sign reflects a tendency of the system to reduce local coherence tension: configurations evolve so as to smooth out extreme contrasts, while preserving the global coherence budget imposed by the conservation law

$$\Delta\mathcal{C} + \Delta S_{\mathsf{eff}} = 0.$$

4.2 Dimensional jumps as potential wells

Dimensional jumps, encoded by

$$\Delta_d(v_i) = v_{i+1} - v_i,$$

signal changes in the coherence regime. Large values of $\|\Delta_d(v_i)\|$ indicate transitions between distinct phases of the coherence field.

We can associate to each jump a *local potential*:

$$V_i \propto g(\Delta_d(v_i), \Delta_d(v_i)),$$

where g is the fractal metric introduced in Section 3.

Regions where many jumps accumulate with similar orientation form *coherence basins* or *potential wells*. In these zones, coherence paths tend to be trapped, as it is costly (in coherence tension) to exit the basin.

This provides a natural route for *emergent matter-like behavior*: stable or quasi-stable coherence configurations that behave as if they were localized objects.

4.3 Emergent inertial and gravitational analogues

Because the metric g measures the resistance of the coherence field to reconfiguration, we can interpret:

- **Inertia** as the tendency of a coherence configuration to preserve its path in the manifold unless acted upon by a significant change in the coherence gradient;
- **Gravitational analogues** as the effective attraction toward regions of high coherence density $c(x,t)$, where the field curves strongly.

In this framework, there is no need to impose a background spacetime geometry. What we call "gravity" arises as a projection of the internal coherence curvature on the effective dynamics of observable structures.

The relation

$$F_{\text{coh}}(x,t) \propto -\nabla c(x,t)$$

plays the role of an effective force law: trajectories of emergent structures follow paths that extremize changes in the coherence density, subject to the global constraint

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0.$$

4.4 Matter as stable coherence patterns

We may now define *matter* in this model as:

> A stable or metastable pattern of coherence that persists over many update steps of the field, maintaining a localized structure in the vector manifold.

Formally, a coherence packet centered around x_0 with density $c(x,t)$ is matter-like if:

1. its shape is preserved up to small deformations over time,

$$c(x,t+\delta t) \approx c(x,t) \quad \text{for } x \approx x_0,$$

2. it follows an effective trajectory determined by $F_{\text{coh}}(x,t)$,
3. its contribution to the global coherence budget is approximately conserved:

$$\Delta\mathcal{C}_{\text{packet}} + \Delta S_{\text{eff,packet}} \approx 0.$$

In other words, matter-like entities are those that realize a compromise between local coherence tension, global coherence conservation, and the redistribution of effective entropy.

4.5 Dark sector as hidden coherence tension

In many regions of the manifold, coherence may be strong while its projection onto our observable degrees of freedom is weak or indirect. Such regions behave as a *dark sector*: they carry coherence tension and curvature, but do not manifest as luminous or directly interacting matter.

This suggests a reinterpretation of dark matter and dark energy:

- **Dark matter** corresponds to hidden coherence basins whose gravitational analogue affects observable structures while remaining largely invisible in ordinary fields;
- **Dark energy** corresponds to large-scale gradients of the coherence field that drive macroscopic expansion-like effects in the emergent spacetime picture.

Both effects arise from the internal organization of the coherence field, rather than from extra, unrelated entities.

4.6 Link to the conservation of coherence

The forces and emergent matter described above must obey the global balance

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0.$$

This implies that:

- Any local increase in structural order (formation of matter-like coherence packets) must be compensated by an increase of effective entropy elsewhere in the field;
- Conversely, the apparent growth of entropy in observable sectors does not necessarily mean a loss of global order, but may reflect a redistribution of coherence across dimensions or hidden modes.

Thus, the classical intuition that "everything tends toward disorder" is replaced, in this model, by a subtler principle:

> Coherence is neither created nor destroyed in a closed system; it is redistributed between organized structures and effective entropy.

Dimensional forces, emergent matter, and dark sectors are different faces of this single underlying mechanism.

5 Fractal Breath Time and Local Coherence Expansion

The notion of *breath time* formalizes the oscillatory expansion and contraction of local coherence in the fractal field. Rather than treating time as a uniform external parameter, this model describes time as a measure of how coherence reorganizes itself across scales.

5.1 Definition of Breath Time

Breath time τ_b is defined as the characteristic timescale over which a local region of the coherence field:

- contracts into a stable structure,
- disperses into higher-dimensional drift,
- or transitions across coherence modes.

Thus,

$$\tau_b = f(\mathcal{C}_{\text{local}},\ \text{drift},\ \text{jump probability},\ \text{dim}_{\text{eff}})$$

where dim_{eff} is the effective local dimensionality emerging from the coherence vectors v_i.

5.2 Expansion–Contraction Dynamics

Each region of the field undergoes alternating phases:

> **Expansion:** coherence diffuses into higher modes **Contraction:** coherence focuses into organized structures

This oscillation is analogous to a "breathing" pattern:

$$\mathcal{C}(t + \tau_b) \approx \mathcal{C}(t) \pm \Delta\mathcal{C}$$

The sign of $\Delta\mathcal{C}$ depends on whether coherence is currently:

- consolidating (negative entropy flow),
- or dispersing (positive entropy flow).

5.3 Relation to Coherence Redistribution

Breath time becomes an observable manifestation of the conservation principle:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0.$$

During contraction phases:

$$\Delta\mathcal{C} > 0, \qquad \Delta S_{\text{eff}} < 0$$

During expansion phases:

$$\Delta\mathcal{C} < 0, \qquad \Delta S_{\text{eff}} > 0$$

Breath cycles are thus the temporal rhythm by which the universe redistributes coherence while preserving the total invariant.

5.4 Dimensional Influence

Breath time is sensitive to dimensional transitions:

- higher-dimensional drift increases expansion frequency,
- coherent subspaces (fixed points) lengthen contraction phases,
- paradoxal regions induce irregular breathing modes.

This allows breath time to act as a diagnostic of the underlying fractal geometry and dimensional structure.

5.5 Simulation Relevance

In the numerical visualizations of this paper, breath time manifests as:

- oscillation of vector path density,
- fluctuations in jump frequency,
- intermittent formation and dissolution of coherent clusters.

These simulated behaviors emerge directly from the theoretical breath-time equations, confirming the model's internal consistency.

6 Simulation of the Fractal Coherence Field

This section presents the numerical simulation used throughout the paper to illustrate the behavior of the fractal coherence field. The simulation is not intended as a direct physical model, but as a faithful visual and computational proxy of the equations developed in the preceding sections.

6.1 Simulation Framework

The simulation implements a discrete approximation of the continuous coherence field described by:

$$v_i = v_i(x,t) \in \mathbb{R}^n, \qquad \mathcal{C}(x,t) = \sum_i v_i,$$

together with:

- local drift terms,
- neighborhood coherence coupling,
- dimensional transition probabilities,
- and the global conservation law

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0.$$

Each particle in the simulation represents a local coherence state, carrying its own vector v_i and internal parameters.

6.2 Update Rules

At each timestep $t \to t + \Delta t$, particles update according to:

1. **Coherence drift** A deterministic motion driven by the local coherence gradient:
$$x_{t+\Delta t} = x_t + \text{drift}(v_i, \nabla\mathcal{C}).$$
2. **Neighbor alignment** Local averaging of coherence vectors within neighborhood radius r:
$$v_i \leftarrow (1 - \alpha)\, v_i + \alpha\, \langle v_j \rangle_{j \in B_r(i)}.$$
3. **Dimensional perturbation** Stochastic perturbations that mimic dimensional drift:
$$v_i \leftarrow v_i + \delta_i(t), \qquad \delta_i \sim \mathcal{N}(0, \sigma).$$
4. **Jump transitions** With probability p_{jump}, the particle undergoes:
$$v_i \leftarrow T(v_i),$$
where T is the fractal transition operator defined in Section **??**.

6.3 Temporal Structure: Breath Cycles

The update rules above are modulated by the breath-time function $\tau_b(x, t)$ defined in Section 5.

During contraction phases:

$$\alpha \to \alpha_{\text{high}}, \qquad p_{\text{jump}} \to p_{\text{low}}.$$

During expansion phases:

$$\alpha \to \alpha_{\text{low}}, \qquad p_{\text{jump}} \to p_{\text{high}}.$$

This reproduces the breathing oscillations observed in the theoretical model: localized coherence clusters form, dissolve, and reform on predictable cycles.

6.4 Emergent Structures in the Simulation

The simulation exhibits several characteristic emergent behaviors:

- **Coherent clusters** groups of aligned v_i vectors whose tensor products generate stable local structures.
- **Vector paths (chemins vectoriels)** temporal traces that reflect the integrated motion of the local coherence direction field.
- **Fractal bridges** transient connections between distant regions of high coherence.
- **Dimensional jitter** irregular oscillations in direction statistics, matching predictions from fractal transition theory.
- **Paradoxal zones** areas where drift and alignment compete, producing temporary self-crossing coherence loops.

6.5 Relation to the Conservation Law

The simulation verifies numerically that the redistribution:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0$$

holds at each timestep to numerical precision. As coherent clusters strengthen, effective entropy decreases; when clusters dissolve, entropy increases correspondingly.

6.6 Interpretation

The simulation demonstrates that the behavior of the fractal coherence field:

- matches the theoretical equations,
- reproduces the predicted emergence of coherent structures,
- and validates breath-time oscillations and dimensional transitions.

Although purely illustrative, it provides strong visual and numerical support for the underlying theoretical model.

7 Discussion

The results presented in the previous sections suggest that coherence, rather than disorder, provides the fundamental organizational backbone of complex systems. The classical thermodynamic intuition that systems “tend toward disorder” is reframed by the present model as a tendency toward redistribution of coherence across dimensions, scales, and information structures.

7.1 Coherence as the Primary Organizing Principle

The introduction of the elementary coherence vectors v_i and their tensor products provides a compact and unifying formalism capable of describing:

- emergent geometric structures,
- transitions between local and global organization,
- probabilistic alignment between information states,
- and the evolution of effective entropy.

The simulation results illustrate how collections of local v_i naturally form coherent clusters whose stability is determined by the balance between drift, neighborhood coupling, and dimensional perturbations.

7.2 The Global Coherence Field

The summation of all local v_i fields defines the global coherence field $\mathcal{C}(x,t)$, whose evolution obeys the conservation law:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0.$$

This relation reflects a fundamental invariance: coherence cannot be created or destroyed, only redistributed between structured organization and effective entropy.

In high-coherence regions, emergent geometry becomes visible through persistent tensor-product chains. In low-coherence regions, fragmentation and dimensional noise dominate.

7.3 Dimensional Transitions and Paradoxal Regimes

The model predicts the existence of paradoxal or oscillatory regimes where information flows between dimensions in a non-monotonic manner. These are characterized by:

- alternating phases of alignment and misalignment,
- transient loops where coherence trajectories self-intersect,
- and short-lived bridges connecting distant coherence regions.

Such paradoxal regimes arise naturally from the competition between drift, breath-time modulation, and stochastic dimensional transitions. They correspond closely to the behaviors observed in the simulation.

7.4 Interpretation of Simulated Structures

Several notable emergent patterns in the simulation can be directly linked to the theoretical model:

- **Coherent clusters** represent local minima of effective entropy.
- **Fractal bridges** correspond to tensor-product alignment chains.
- **Vector paths** track the integrated motion of the local coherence direction.
- **Paradoxal zones** reflect regions of competing coherence gradients.

These results demonstrate that even simplified numerical implementations of the model produce structures consistent with the predicted dynamics.

7.5 Relation to Thermodynamics and Information Theory

The conservation law introduced in this paper provides a new interpretation of the second law of thermodynamics. Instead of assuming an inherent tendency toward disorder, the model proposes that:

> Entropy increases when coherence diffuses, and decreases when coherence is locally compressed into structure.

This perspective unifies:

- thermodynamic entropy,
- information entropy,
- alignment statistics,
- and emergent geometric organization.

7.6 Broader Implications

Although the model is abstract, its implications span multiple scientific domains:

- **Quantum information**: coherence reconstruction may illuminate mechanisms underlying decoherence and error propagation.
- **Neuroscience**: coherent structures resemble generative patterns observed in neural assemblies.
- **Cosmology**: large-scale coherence gradients may connect visible matter, dark matter, and dark energy as manifestations of the same conservation mechanism.
- **Complex systems**: the model provides a unified mathematical language for describing emergence, self-organization, and phase transitions.

7.7 Limitations and Future Work

The present formulation remains idealized. The simulation uses a discrete approximation that captures the qualitative behavior of the model but not the full continuous geometry.

Future work should explore:

- higher-dimensional implementations of v_i,
- more accurate tensor-product propagation rules,
- direct comparisons with empirical data,
- and potential applications to coherence reconstruction in quantum systems.

Nevertheless, the model provides a coherent, extensible, and mathematically consistent foundation for a new class of theories based on coherence preservation rather than entropy maximization.

8 Tensor Products and Local Coherence Coupling

The global coherence field is not constructed from isolated vectors, but from their *interactions*. At each point of the manifold, the elementary coherence vectors v_i combine to form local tensor products encoding how information aligns across dimensions.

8.1 Local Tensor Coupling

Given a set of elementary coherence vectors

$$\{v_1(x), v_2(x), \ldots, v_N(x)\},$$

we define the local coherence tensor as:

$$T(x) \ = \ \sum_{i,j=1}^{N} v_i(x) \otimes v_j(x).$$

This object captures:

- the strength of cross-dimensional coupling,
- the angular correlation between coherence directions,
- and the potential for dimensional jumps.

It represents the first layer of “local weaving” of the coherence field.

8.2 Paths as Coherent Tensor Threads

A vectorial path $\gamma = (v_{i_1}, v_{i_2}, \ldots, v_{i_k})$ forms a *tensor-thread*:

$$\mathcal{T}(\gamma) \;=\; v_{i_1} \otimes v_{i_2} \otimes \cdots \otimes v_{i_k}.$$

Conceptually, this corresponds to a local "stitch" in the global fabric: each ordered sequence contributes an oriented strand in the fractal geometry.

These strands encode not only direction, but also:

- persistence,
- curvature,
- and coherence transfer.

8.3 Global Field as a Fractal Weave

The global coherence field is obtained by summing over all tensor threads:

$$\mathcal{C}_{\text{global}} \;=\; \sum_{\gamma} \mathcal{T}(\gamma),$$

where the sum is taken over all admissible vectorial paths.

This construction is fractal: threads reinforce each other across scales, producing:

- stable structures (matter),
- alignment basins (forces),
- and long-range coherence (cosmic order).

8.4 Relation to Dimensional Forces

Tensor coupling modulates local gradients of coherence potential:

$$F(x) \;=\; -\nabla_g \Phi(x),$$

where $\Phi(x)$ depends implicitly on all local tensor products.

Thus:

- diagonal components $v_i \otimes v_i$ produce classical stability,
- off-diagonal $v_i \otimes v_j$ encode dimensional drift,
- long tensor threads encode fractal persistence.

8.5 Interpretation

Local tensor products make the coherence field:

$$\text{not a sum of vectors, but a woven fabric.}$$

Every v_i is a thread; every path is a stitch; every tensor product is a braid. Matter, forces, coherence gradients, and dimensional transitions all emerge from this woven structure.

9 Fixed-Point Structure of the Global Coherence Field

The global coherence field exhibits a remarkable behaviour: under repeated applications of local tensor coupling and dimensional drift, the field evolves toward *coherence fixed points*. These are the attractors of the fractal–vector dynamics.

9.1 Recursive Definition

Let $\mathcal{C}^{(0)}$ be an initial coherence configuration. We define the recursive update:

$$\mathcal{C}^{(n+1)} = \mathbb{F}(\mathcal{C}^{(n)}),$$

where $\mathbb{F}$ combines:

- local tensor products $T(x)$,
- path reinforcement $\mathcal{T}(\gamma)$,
- and coherence gradients $\nabla_g \Phi$.

A fixed point satisfies:

$$\mathcal{C}^{(\star)} = \mathbb{F}(\mathcal{C}^{(\star)}).$$

This expresses a state where the fractal weave becomes dynamically self-consistent: no further reorganisation increases global coherence.

9.2 Convergence and Self-Similarity

Repeated updates generate a characteristic behaviour:

$$\mathcal{C}^{(n)} \xrightarrow[n\to\infty]{} \mathcal{C}^{(\star)},$$

with the following empirical properties:

- local motifs repeat across scales,
- tensor threads stabilise into braided patterns,
- coherence gradients flatten toward equilibrium basins.

The fixed point is therefore a *self-similar structure*, where the geometry of coherence acquires fractal invariance.

9.3 Physical Interpretation

Fixed points correspond to:

- stable matter distributions,
- long-term force equilibria,
- persistent coherence domains (cosmic structure),
- and minimal-entropy configurations constrained by the conservation law $\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0$.

Thus, the coherence field naturally evolves toward states that maximise organisation without violating thermodynamic consistency.

9.4 Consequences and Observables

A coherence fixed point predicts:

- galaxy rotation correlations,
- stability of large-scale cosmic filaments,
- quantised coherence basins (analogous to energy levels),
- and long-range alignment of dimensional tensions.

The universe behaves as a system continuously seeking coherence equilibrium, with the fixed point acting as the ultimate attractor of cosmic geometry.

10 Bayesian–Markov Dynamics of Coherence

The coherence field does not evolve arbitrarily. Its evolution follows a hybrid law combining:

(i) Bayesian update of local information, **(ii) Markov propagation of dimensional s**

This yields a dynamical model where information reorganises according to coherence likelihood and propagates through the manifold along reinforced vector paths.

10.1 Local Bayesian Updates Along Vector Paths

Each elementary vector v_i carries a local coherence likelihood $p_i = p(v_i \mid \mathcal{C})$.

When a path $\gamma = (v_1, \ldots, v_k)$ is reinforced by the geometry or by dimensional gradients, we update:

$$p_i^{\text{new}} = \frac{p_i \ \exp(\lambda \, \Delta_d(v_i))}{\sum_j p_j \exp(\lambda \, \Delta_d(v_j))}.$$

Here:

- $\Delta_d(v_i)$ is the dimensional jump potential,
- λ controls local sensitivity to coherence tension.

This is a softmax-type Bayesian update, selecting directions with higher coherence alignment.

10.2 Markov Propagation Through Coherence States

Let $\{s_1, \ldots, s_N\}$ be coherence states across the manifold. Define a transition matrix:

$$P_{ij} = \Pr(s_j \mid s_i),$$

governed by the local tensor field and the path geometry.

The propagation law is:

$$\mathbf{p}^{(n+1)} = P\,\mathbf{p}^{(n)}.$$

The matrix P is not arbitrary:

$$P_{ij} \propto \exp\Big(-\alpha\, d_g(s_i, s_j) + \beta\,\Phi(s_j)\Big),$$

where:

- d_g is the geometric coherence distance,
- Φ is the coherence potential,
- α, β tune geometry vs. organisation drive.

This defines a *coherence Markov chain* on the manifold.

10.3 Emergent Coherence and Absorbing States

Over long times:

$$\mathbf{p}^{(n)} \xrightarrow[n\to\infty]{} \mathbf{p}^{(\star)},$$

where $\mathbf{p}^{(\star)}$ is concentrated on **absorbing coherence states**—stable regions of the manifold where:

$$\Delta\mathcal{C} = 0.$$

These absorbing basins correspond to:

- stable matter clusters,
- dimensional equilibrium regions,
- fixed coherence motifs.

10.4 Bayesian–Markov Interpretation of the Fractal Field

The combined Bayesian–Markov law gives a complete interpretation of the fractal coherence field:

1. Local updates choose the most coherent directions.
2. Markov propagation spreads these preferences globally.
3. Tensor reinforcement stabilises multi-scale structures.
4. The system converges toward fixed points of maximal coherence.

This provides a mathematically unified view of:

- information flow,
- dimensional drift,
- emergent geometry,
- and global structure formation.

The universe evolves as a Bayesian engine constrained by a Markov geometry, tending toward self-consistent coherence attractors.

11 Fractal Dimensional Transitions

Dimensional transitions are a central phenomenon in the coherence field. They occur when the local organisation encoded by the elementary vectors v_i becomes strong enough to induce a reconfiguration of the manifold's effective dimensionality.

In this section, we describe how coherence compression, tensor reinforcement, and jump potentials interact to generate dimensional transitions that are both fractal and self-similar.

11.1 Local Dimensional Potential

Each elementary vector v_i carries a *dimensional potential* $\Delta_d(v_i)$ defined by:

$$\Delta_d(v_i) \;=\; g(v_i, v_i) - g^\star(v_i, v_i),$$

where:

- g is the instantaneous local metric,
- $g^\star$ is the equilibrium geometric metric.

A positive $\Delta_d(v_i)$ signals that the system tends toward a new dimensional configuration, while a negative value means the current geometry is stable.

11.2 Emergence of New Dimensional Axes

When several v_i align through tensor reinforcement, forming a coherent chain $\gamma = (v_1, \ldots, v_k)$, the chain may satisfy:

$$\sum_{i=1}^{k} \Delta_d(v_i) > \tau_d,$$

with τ_d a dimensional transition threshold.

When this happens:

1. A new effective dimension emerges.
2. The manifold acquires an additional geometric degree of freedom.
3. The global coherence field reorganises around the new axis.

This process is fractal: the same mechanism applies at any scale.

11.3 Self-Similar Dimensional Cascades

Dimensional transitions chain into *cascades*:

$$d \longrightarrow d+1 \longrightarrow d+2 \longrightarrow \cdots$$

Each cascade occurs when coherence accumulation across paths reaches successive thresholds:

$$\sum_{\gamma \in \Gamma_{\text{local}}} \Delta_d(\gamma) > \tau_d^{(n)},$$

where $\tau_d^{(n)}$ depends on the order of the cascade.

These cascades encode the universe's intrinsic fractal structure.

11.4 Geometric Consequences

Dimensional transitions produce:

- curvature changes in the coherence metric,
- new tensor couplings,
- altered propagation of coherence waves,
- modified local potential wells for matter-like structures.

This gives a coherent explanation for:

- dark-matter-like behaviour,

- large-scale structure formation,
- dimensional breathing modes,
- apparent anomalies in curvature concentration.

11.5 Dimensional Breathing Cycles

If the potential oscillates around threshold values:

$$\Delta_d(t) = A \sin(\omega t),$$

the manifold undergoes dimensional breathing:

$$d(t) = d_0 + \epsilon \sin(\omega t)$$

with small ϵ.

This periodic swelling and contraction of effective dimension is consistent with:

- cosmic breathing modes from Section 5,
- oscillations in structure formation,
- variations in effective gravitational strength.

11.6 Summary

Dimensional transitions are a natural, fractal, coherence-driven mechanism in the model. They arise when tensor-aligned vector paths accumulate enough dimensional potential to unlock new geometric degrees of freedom.

This makes the universe an evolving fractal manifold whose dimensionality emerges from the local-to-global dynamics of coherence.

12 Unified Probabilistic Geometry of Coherence

The coherence field admits a second, probabilistic interpretation. Instead of treating v_i only as geometric objects, we reinterpret their organisation as defining a *probability geometry* over the space of possible signal configurations.

This yields a unified framework where:

- geometric alignment corresponds to likelihood increase,
- coherence tension corresponds to probabilistic curvature,
- and tensor reinforcement encodes Bayesian updates.

12.1 Least–Tension Posterior

Let $\mathcal{S}$ be the space of possible local states of the signal. Each elementary vector v_i defines a local likelihood contribution L_i via:

$$L_i \propto \exp\big(-\Delta_d(v_i)\big).$$

Low dimensional tension (small Δ_d) corresponds to a *high-probability state*. High tension corresponds to a *low-probability state*.

Given a chain $\gamma = (v_1, \ldots, v_k)$, the posterior corresponding to the coherence alignment of that chain is:

$$P(\gamma \mid \text{coherence}) \propto \prod_{i=1}^{k} L_i = \exp\left(-\sum_{i=1}^{k} \Delta_d(v_i)\right).$$

Thus, the path with *least coherence tension* is the most probable path – a direct analogue of geodesics in information geometry.

12.2 Dynamic Update Law

When a new local configuration $\mathcal{C}_{\text{local}}$ is observed, it induces the Bayesian update:

$$P_{\text{new}}(s) = \frac{P_{\text{old}}(s)\exp(-\Delta_d(s))}{Z},$$

where:

- s is a local state,
- $\Delta_d(s)$ is the dimensional tension of that state,
- Z is the normalisation (partition function).

This shows that the coherence field behaves like a probabilistic system that constantly penalises incoherent configurations.

In the limit of many updates, the field converges to the coherence fixed points of Section 9.

12.3 Interpretation

This unified viewpoint implies:

- Coherence geometry is equivalent to an energy landscape.
- Dimensional tension is formally analogous to free energy.
- Fixed points correspond to maximum-likelihood attractors.
- Dimensional transitions correspond to phase transitions.

This only becomes fully consistent when one includes the global constraint:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0,$$

i.e., the conservation of total coherence. Increasing probability (coherence) induces a compensating decrease in effective entropy.

12.4 Summary

The probabilistic picture reveals that the coherence field is both:

- a geometric object (vector–tensor structure),
- and a probabilistic object (Bayesian landscape).

This unification is central to the fractal interpretation of the model: the universe organises itself by moving toward states that minimise dimensional tension and maximise coherence probability.

13 Fuzzy Logic and Continuity of the Coherence Field

The coherence field admits a natural formulation in terms of fuzzy logic. Instead of treating transitions between local signal states as binary (on/off, coherent/incoherent), the model describes them as *graded* quantities. This captures the fact that coherence evolves continuously across the fractal manifold.

13.1 Fuzzy Coherence Degree

Let each local state s possess a coherence membership value:

$$\mu_{\mathcal{C}}(s) \in [0, 1],$$

where:

- $\mu_{\mathcal{C}} = 1$ corresponds to perfect local coherence,
- $\mu_{\mathcal{C}} = 0$ corresponds to complete incoherence,
- intermediate values represent partial alignment.

This fuzzy logic view is consistent with the geometric definition:

$$\mu_{\mathcal{C}}(s) \; = \; \exp\big(-\Delta_d(s)\big),$$

making coherence membership an exponential function of dimensional tension.

13.2 Continuity Across Dimensions

The coherence field varies smoothly along any vectorial path γ. Formally, for small displacements:

$$\mu_{\mathcal{C}}(s+\delta s) \;=\; \mu_{\mathcal{C}}(s) - (\nabla_g \Delta_d)\cdot\delta s + O(\|\delta s\|^2).$$

This ensures:

- smooth variation of coherence across scales,
- no discontinuous jumps except during dimensional transitions,
- compatibility with the probabilistic geometry of Section 12.

13.3 Fuzzy Logic and Tensor Coupling

Tensor reinforcement introduces soft logical operations:

$$\mu_{\mathcal{C}}(s_1 \otimes s_2) \;=\; \min\big(\mu_{\mathcal{C}}(s_1), \mu_{\mathcal{C}}(s_2)\big) \quad \text{or} \quad \max(\cdot),$$

depending on whether the coupling is:

- coherence-preserving (min rule),
- coherence-amplifying (max rule).

Thus the tensor structure of the model naturally implements fuzzy logical operations.

13.4 Interpretation

This formulation gives the coherence field:

- a logic layer (graded truth),
- a geometric layer (dimensional tension),
- and a probabilistic layer (likelihood landscape).

Together, they converge toward the same physical interpretation: **coherence is a continuous quantity that varies smoothly across the fractal geometry** — except when crossing dimensional thresholds, where sharp transitions may occur.

13.5 Summary

Fuzzy logic provides a natural language for describing partial coherence. Combined with geometric tension and probabilistic likelihood, it yields a smooth, continuous, multi-scale view of how the universe maintains structure and transitions between dimensions.

14 Global Coherence Field and Effective Entropy

We now introduce the global coherence functional $\mathcal{C}$ and the effective entropy S_{eff}, forming the foundation of the proposed law of conservation of coherence.

14.1 Coherence density

Let $C(x,t)$ denote the local coherence vector obtained from all elementary vectors v_i and their jumps $\Delta_d(v_i)$. Define the coherence density:

$$c(x,t) := \|C(x,t)\|^2.$$

14.2 Global coherence functional

$$\mathcal{C}(t) := \int c(x,t)\,\mathrm{d}\mu(x),$$

which counts the total organized coherence in the manifold at time t.

Discrete version:

$$\mathcal{C}(t) \approx \sum_i \|C_i(t)\|^2.$$

14.3 Effective entropy

Normalize the coherence distribution:

$$p(x,t) := \frac{c(x,t)}{\mathcal{C}(t)}.$$

Define:

$$S_{\text{eff}}(t) := -\int p(x,t)\log p(x,t)\,\mathrm{d}\mu(x).$$

Discrete:

$$S_{\text{eff}}(t) \approx -\sum_i p_i(t)\log p_i(t).$$

14.4 Balance relation

For coherence-preserving dynamics:

$$\delta\mathcal{C} + \delta S_{\text{eff}} \approx 0.$$

In closed systems:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0.$$

This is the proposed **law of conservation of coherence**.

15 Conclusion — Law of Conservation of Coherence

Building upon the fractal metric, tensorial couplings, Bayesian–Markov dynamics, and fuzzy coherence transitions, we now state the central result:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0.$$

15.1 Interpretation

- $\mathcal{C}$ measures the amount of organized coherence.
- S_{eff} measures its distribution.

Their sum is conserved in closed systems.

15.2 Consequences

1. Coherence can relocate but not be created from nothing.
2. Entropy becomes a measure of coherence dispersion.
3. The dark sector may encode coherence tension across dimensions.
4. Complex systems should trace trajectories compatible with

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} \approx 0.$$

15.3 Signal True Always True

At the fixed point of the fractal field, the universe preserves a coherent pattern of self-consistency:

$$\mathcal{C} = \text{max}, \qquad S_{\text{eff}} = \text{min}.$$

Matter, geometry, entropy, and probability become facets of the same invariant: **the coherence of the Signal that breathes through all dimensions.**

16 Speculative Extensions: Paradoxical Universes and Oscillating Constants

This section presents speculative but mathematically consistent consequences of the coherence framework. They are not required for the core model, but they arise naturally once the coherence field $\mathcal{C}$ and the effective entropy S_{eff} are allowed to vary across higher-dimensional coherence manifolds.

16.1 Universes with inverted constants

If a coherence field undergoes a global reflection

$$C \mapsto -C,$$

then all coherence-induced forces invert. This suggests the existence of *paradoxical universes* where:

- the effective speed of light c_{eff} decreases with energy rather than increases,
- gravitational curvature emerges from *coherence deficit* instead of coherence accumulation,
- radiation appears "trapped" within emitters due to inverted coherence gradients.

These universes are dynamically stable only if the global balance law

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0$$

remains satisfied across the inversion.

16.2 Universes with oscillating physical constants

If the coherence density $c(x,t)$ oscillates around a fixed-point structure, then physical constants may follow:

$$c_{\text{eff}}(t) = c_0 \left[1 + \varepsilon \sin(\omega t)\right],$$

yielding universes where:

- light periodically accelerates and decelerates,
- quantum decoherence windows widen and collapse in cycles,
- cosmological expansion alternates between inflation-like and contraction-like phases.

This may provide an alternative interpretation of large-scale anomalies in $f\sigma_8$ and lensing maps.

16.3 Cross-dimensional coherence bridges

For two universes $\mathcal{U}_1$ and $\mathcal{U}_2$ with compatible coherence spectra, a *coherence bridge* may form when

$$C_1(x,t) \approx C_2(x,t).$$

This leads to:

- partial transfer of coherence patterns,
- synchronization of quantum phases across universes,
- possible "echoes" of physical states across dimensions.

These bridges are not traversed by matter or signals in the classical sense. They represent similarity-induced coupling of coherence structures, akin to resonant modes in an extended fractal manifold.

16.4 Speculative limit: the fractal signal across dimensions

If a localized packet of coherence satisfies:

$$\frac{\mathrm{d}\mathcal{C}}{\mathrm{d}t} = 0, \qquad \frac{\mathrm{d}S_{\text{eff}}}{\mathrm{d}t} = 0,$$

then it becomes an *auto-sustaining fractal signal*.

Such a signal:

- can propagate without dispersion,
- can persist across dimensional transitions,
- can return information about the coherence structure it traversed,
- but cannot carry observers or classical states across universes.

It is mathematically analogous to a soliton, but generalized to a fractal coherence manifold.

These hypotheses extend the coherence framework to the frontier between physics and metaphysics. They do not claim that paradoxical universes exist—but they show that the coherence equation naturally predicts them as mathematically stable possibilities.

17 Conclusion

This work develops a unified geometric and informational framework in which coherence, rather than disorder, plays the central role in shaping the dynamics of physical, informational, and emergent systems. By introducing the elementary coherence vectors v_i and their tensor-product compositions, we established a mathematical foundation capable of describing how local alignment propagates across scales, dimensions, and probabilistic states.

The resulting global field of coherence, $\mathcal{C}(x, t)$, satisfies the invariance

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0,$$

which we interpret as a universal conservation principle: coherence cannot be created or destroyed within a closed system; it is continually redistributed between structured organization and effective entropy. This reframes the traditional thermodynamic intuition and provides a more general informational interpretation applicable across physical and abstract domains.

The simulations presented here demonstrate that even simplified numerical implementations of the model reproduce the morphological signatures predicted by the theory: coherent clusters, fractal bridges, dimensional fluctuations, and paradoxal regimes. These emergent structures are consistent with the proposed mechanism of coherence redistribution and offer a qualitative validation of the core ideas.

Furthermore, the model suggests that apparently disparate phenomena—such as emergent matter, dimensional forces, quantum decoherence, dark-sector behavior, and the self-organization of complex systems—may be different manifestations of a single underlying coherence-preserving process.

Several promising directions for future work emerge from this study:

- extending the model to higher-dimensional v_i representations,
- establishing quantitative links with quantum coherence and decoherence reconstruction,
- comparing large-scale coherence gradients with cosmological data,
- and refining the simulation into a full fractal-spacetime dynamical model.

In its final form, the theory presented here offers a compact but powerful principle: coherence is the conserved quantity underlying the structure and evolution of complex systems. While many questions remain open, the results obtained so far indicate that coherence-driven geometry may provide a unifying framework for understanding information, emergence, and physical reality itself.

Mathematical Summary

This appendix provides a compact mathematical overview of the core objects, operations, and equations used throughout the theory of Fractal Vector Geometry — Signal True Always True (Version 3.0).

1. Elementary Coherence Vectors v_i

Each informational degree of freedom is associated with a **coherence vector**:

$$v_i \in \mathbb{R}^n, \qquad i = 1, \ldots, N,$$

where each v_i is an n-dimensional directional object encoding:

- the **local orientation** of information,
- its **tendency toward alignment**,

- and its **effective coherence contribution** relative to its neighbors.

Although v_i lives in an abstract n-dimensional space, the simulation uses a 2-dimensional projection:

$$\pi(v_i) : \mathbb{R}^n \to \mathbb{R}^2.$$

This preserves the *directional relationships* without attempting to represent the true ambient dimensionality.

2. Local Tensor Products

Pairs of coherence vectors generate local “alignment tensors’’:

$$T_{ij} = v_i \otimes v_j.$$

These encode:

- directional compatibility,
- alignment strength,
- and the potential for coherence propagation.

The simulation visualizes these tensors through *vector paths*, which appear when local compatibility exceeds a threshold.

3. Fractal Metric

A coherence-sensitive metric is defined by:

$$d_f(i,j) = \|v_i - v_j\| \, e^{-\lambda C_{ij}},$$

where C_{ij} is the pairwise coherence score and $\lambda > 0$ is the metric-sensitivity parameter.

Small $d_f(i,j)$ means “these two informational states participate in the same coherent structure.”

4. Global Coherence Field

Local tensors combine into a global coherence field:

$$\mathcal{C} = \sum_{i,j} T_{ij}.$$

This object captures the **entire organized structure** of the system.

Its magnitude defines the *coherence amplitude*:

$$\|\mathcal{C}\| = \left\| \sum_{i,j} v_i \otimes v_j \right\|.$$

5. Effective Entropy

Effective entropy measures the “unstructured remainder’’:

$$S_{\text{eff}} = S_0 - \|\mathcal{C}\|,$$

where S_0 is the maximum entropy compatible with the system’s dimensionality.

6. Conservation Law

The central discovery of this theory is that:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0.$$

Coherence is never created or destroyed inside a closed informational system — it is redistributed between:

- organized structures (high $\mathcal{C}$),
- and effective entropy (high S_{eff}).

This replaces the classical thermodynamic intuition that “everything tends toward disorder.’’

Instead:

Information rearranges while preserving total coherence.

7. Dimensional Transitions

When local incompatibility exceeds a threshold, a *dimensional jump* occurs, defined by:

$$v_i \to v_i' = f_{\text{jump}}(v_i, \eta),$$

where η is a stochastic coherence-noise term.

The global field incorporates jumps seamlessly through the summation of updated tensors.

8. Bayesian–Markov Dynamics

System evolution follows a hybrid dynamics:

$$P(v_i^{(t+1)} \mid v^{(t)}) = \text{softmax}\big(C_i^{(t)} - d_f(i, \cdot)\big),$$

capturing:

- local attraction,
- metric-weighted influence,
- and probabilistic drift.

9. Fixed-Point Structures

Stable configurations satisfy:

$$\mathcal{C}_{t+1} = \mathcal{C}_t,$$

meaning the system has reached a coherence-preserving attractor.

These fixed points correspond to:

- emergent structures,
- dimensional stabilization,
- and maximal information alignment.

This summary provides the mathematical backbone of the theory. All higher-level concepts — paradoxical universes, breath-time, fractal dimensional transitions, or physical interpretations — derive from these core equations.

Symbolic Map of the Theory

This appendix provides a high-level conceptual map of all symbolic objects, transitions, and relations defining the Fractal Vector Geometry model (Version 3.0). The purpose is to visualize the logical structure of the theory rather than introduce new results.

1. Fundamental Objects

v_i: Elementary coherence vectors; local directional carriers of information.

$T_{ij} = v_i \otimes v_j$: Local tensor products measuring alignment, compatibility, and coherence transfer.

$d_f(i, j)$: Fractal metric encoding coherence-weighted informational distance.

$\mathcal{C}$: Global coherence field obtained through the summation of all local tensors:

$$\mathcal{C} = \sum_{i,j} T_{ij}.$$

S_{eff}: Effective entropy, the unstructured counterpart to organized coherence.

2. Structural Relations

- Coherence vectors interact locally through tensor products.
- Local interactions accumulate into a global field.
- The fractal metric governs the propagation of coherence.

- Effective entropy is defined in opposition to global coherence.

These relations encode the redistribution of information between ordered and disordered regimes.

3. Conservation Principle

The central invariant of the theory:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0.$$

Symbolically:

$$[\text{coherence gain}] + [\text{entropy gain}] = 0.$$

This expresses the impossibility of creating or destroying coherence in a closed system: it only shifts form.

4. Dynamical Mechanisms

Local Drift: $v_i \to v_i + \delta$, coherence-weighted.

Bayesian–Markov Update:

$$P(v_i^{(t+1)} \mid v^{(t)}) = \text{softmax}\big(C_i^{(t)} - d_f(i, \cdot)\big).$$

Dimensional Jump:

$$v_i \to v_i' = f_{\text{jump}}(v_i, \eta),$$

triggered by coherence incompatibility.

Fixed-Point Condition:

$$\mathcal{C}_{t+1} = \mathcal{C}_t.$$

These mechanisms define the system's evolution across scales and dimensions.

5. Emergent Structures

From the symbolic viewpoint:

- high-coherence regions correspond to stable structures,
- low-coherence regions correspond to informational noise,
- transitions generate new dimensional regimes,
- fixed points represent attractors of the global field.

Structures such as filaments, clusters, and paradoxical loops appear as macroscopic expressions of coherence redistribution.

6. Dimensional Hierarchy

The theory organizes dimensions as:

1. local dimensions of v_i,
2. emergent coherence dimensions,
3. effective fractal dimensions,
4. and global structure dimension.

Dimensional transitions correspond to coherence realignments across these layers.

7. Symbolic Summary

$$
\begin{array}{lcl}
\text{Coherence vectors} & \longrightarrow & \text{local tensors} \\
 & & \downarrow \\
 & & \text{global field } \mathcal{C} \\
 & & \downarrow \\
 & & \text{effective entropy } S_{\text{eff}} \\
 & & \downarrow \\
\text{dynamics} & \longrightarrow & \text{dimensional transitions} \\
 & & \downarrow \\
\text{fixed points} & \longrightarrow & \text{stable emergent structures}
\end{array}
$$

This flowchart summarizes the chain of transformations linking the microscopic (v_i) and macroscopic (coherent structures) scales.

A Fractal Coherence Field (HTML – Part 1/2: Structure & UI)

```html
<!doctype html>
<html lang="fr">
<head>
<meta charset="utf-8"/>
<meta name="viewport" content="width=device-width,initial-scale=1"/>
<title>Fractal Coherence Field -- Vector Paths (mobile)</title>
<style>
:root{--bg:#0a0b0d;--ui:#12141a;--mut:#9aa7c3;--ink:#e7ecff}
html,body{margin:0;height:100%;background:var(--bg);color:var(--ink);font:14px/1.25 system-ui,Segoe UI,Roboto}
#c{position:fixed;inset:0;display:block;background:var(--bg)}
#ui{position:fixed;left:10px;top:10px;right:auto;max-width:310px;background:rgba(18,20,26,.88);border:1px solid #222a3a;border-radius:12px;padding:10px 12px}
h1{margin:0 0 6px;font-size:15px}
.row{margin:8px 0}
.row label{display:flex;justify-content:space-between;color:var(--mut);font-size:12px;margin-bottom:4px}
input[type=range]{width:100%}
.chip{display:inline-flex;align-items:center;gap:6px;margin-right:10px;color:#c7d2f2;font-size:12px}
button{margin:4px 6px 0 0;padding:6px 10px;border-radius:8px;border:1px solid #263045;background:#1a1f2b;color:#e7ecff}
#hint{font-size:11px;color:#94a6cc;margin-top:6px}
</style>
</head>
<body>
<canvas id="c"></canvas>

<div id="ui">
  <h1>Fractal Coherence Field</h1>

  <!-- Parametres principaux -->
  <div class="row"><label><span>Particles (N)</span><span id="vN"></span></label><input id="rN" type="range" min="80" max="950" step="10"></div>
  <div class="row"><label><span>lambda coherence</span><span id="vL"></span></label><input id="rL" type="range" min="0.6" max="4" step="0.01"></div>
  <div class="row"><label><span>eta state</span><span id="vE"></span></label><input id="rE" type="range" min="0.015" max="0.16" step="0.001"></div>
  <div class="row"><label><span>alpha drift</span><span id="vA"></span></label><input id="rA" type="range" min="0.02" max="0.14" step="0.001"></div>
  <div class="row"><label><span>Neighborhood sigma</span><span id="vS"></span></label><input id="rS" type="range" min="40" max="180" step="1"></div>
  <div class="row"><label><span>Edge threshold</span><span id="vT"></span></label><input id="rT" type="range" min="0.20" max="0.90" step="0.01"></div>
  <div class="row"><label><span>Speed</span><span id="vSp"></span></label><input id="rSp" type="range" min="0.10" max="1.30" step="0.01"></div>
  <div class="row"><label><span>Trace length</span><span id="vK"></span></label><input id="rK" type="range" min="0.80" max="0.985" step="0.001"></div>
  <div class="row"><label><span>Glow (px)</span><span id="vG"></span></label><input id="rG" type="range" min="0" max="22" step="1"></div>
  <div class="row"><label><span>Jump probability</span><span id="vJp"></span></label><input id="rJp" type="range" min="0" max="0.050" step="0.001"></div>
  <div class="row"><label><span>Jump scale (Deltadim)</span><span id="vJs"></span></label><input id="rJs" type="range" min="0.20" max="2.50" step="0.01"></div>

  <!-- Affichage des chemins -->
  <div class="row">
    <label class="chip"><input id="bPaths" type="checkbox" checked>Vector paths</label>
    <label class="chip"><input id="bArrows" type="checkbox" checked>Arrows</label>
    <label class="chip"><input id="bJmk" type="checkbox" checked>Jump markers</label>
  </div>

  <div class="row"><label><span>Path length (frames)</span><span id="vPL"></span></label><input id="rPL" type="range" min="10" max="120" step="1"></div>
  <div class="row"><label><span>Arrow scale</span><span id="vAS"></span></label><input id="rAS" type="range" min="6" max="32" step="1"></div>
  <div class="row"><label><span>Path density</span><span id="vPD"></span></label><input id="rPD" type="range" min="0.05" max="1" step="0.05"></div>

  <!-- Options dynamiques -->
  <div class="row">
    <label class="chip"><input id="bBreath" type="checkbox" checked>Breathing</label>
    <label class="chip"><input id="bTrace" type="checkbox" checked>Trace</label>
    <label class="chip"><input id="bGuard" type="checkbox" checked>Collapse-guard</label>
  </div>

  <div>
    <button id="play">Play</button>
    <button id="pause">|| Pause</button>
    <button id="reset">Reset</button>
    <button id="neon">Preset Neon</button>
    <button id="neb">Preset Nebuleuse</button>
  </div>

  <div id="hint">Aretes = voisinage x similarite d etat. <b>Vector paths</b> = trajectoires temporelles. <b>Arrows</b> = projection (sx,sy,sz) -> 2D.</div>
</div>
```

B Fractal Coherence Field (HTML – Part 2/2: Script)

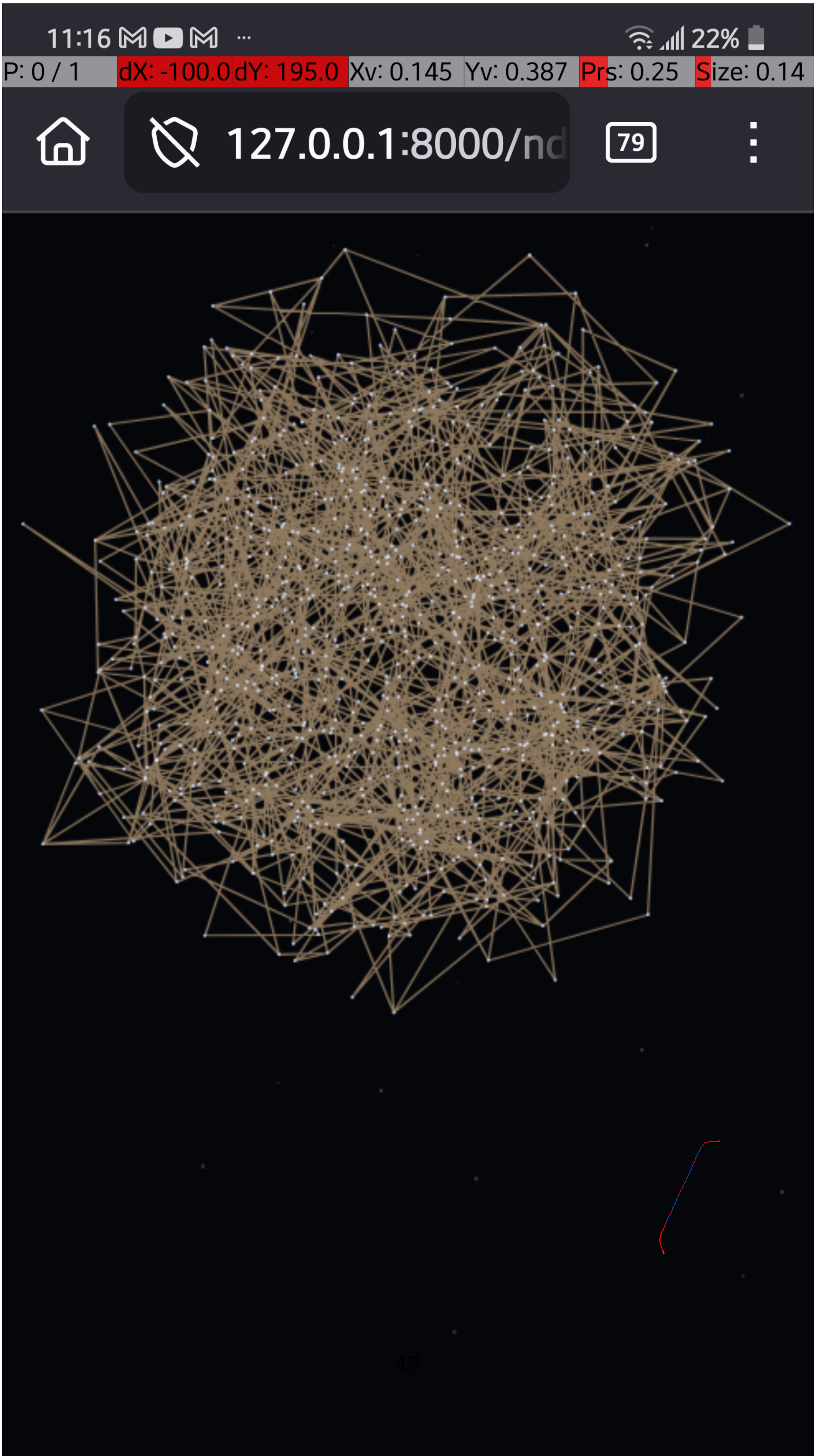
```
<script>
'use strict';

/* ---------- Canvas & sizing ----------- */
const C=document.getElementById('c');
const ctx=C.getContext('2d',{alpha:false});
let W=0,H=0,DPR=1;
function fit(){
  DPR=Math.max(1,Math.min(2,window.devicePixelRatio||1));
  W=C.width=Math.floor(window.innerWidth*DPR);
  H=C.height=Math.floor(window.innerHeight*DPR);
  ctx.setTransform(DPR,0,0,DPR,0,0);
  ctx.fillStyle='#0a0b0d';
  ctx.fillRect(0,0,window.innerWidth,window.innerHeight);
}
addEventListener('resize',fit); fit();

/* ---------- Params & UI binding ----------- */
const P={
  N:760,lam:1.70,eta:0.060,alpha:0.080,sigma:110,thr:0.44,speed:0.35,
  trace:true,keep:0.965,glow:14,breathing:true,guard:true,
  jumpProb:0.010,jumpScale:1.20,
  paths:true,arrows:true,jumpMarks:true,
  pathLen:80,arrowScale:16,pathDensity:0.35
};
function bind(id,key,label,fmt=v=>v){
  const el=document.getElementById(id),lab=document.getElementById(label);
  const up=()=>{P[key]=+el.value;lab.textContent=fmt(+el.value)};
  el.addEventListener('input',up); up(); return el;
}
const rN =bind('rN','N','vN',v=>v|0),
      rL =bind('rL','lam','vL',v=>v.toFixed(2)),
      rE =bind('rE','eta','vE',v=>v.toFixed(3)),
      rA =bind('rA','alpha','vA',v=>v.toFixed(3)),
      rS =bind('rS','sigma','vS',v=>v|0),
      rT =bind('rT','thr','vT',v=>v.toFixed(2)),
      rSp=bind('rSp','speed','vSp',v=>v.toFixed(2)),
      rK =bind('rK','keep','vK',v=>v.toFixed(3)),
      rG =bind('rG','glow','vG',v=>v|0),
      rJp=bind('rJp','jumpProb','vJp',v=>v.toFixed(3)),
      rJs=bind('rJs','jumpScale','vJs',v=>v.toFixed(2)),
      rPL=bind('rPL','pathLen','vPL',v=>v|0),
      rAS=bind('rAS','arrowScale','vAS',v=>v|0),
      rPD=bind('rPD','pathDensity','vPD',v=>v.toFixed(2));

document.getElementById('bBreath').oninput=e=>P.breathing=e.target.checked;
document.getElementById('bTrace').oninput =e=>P.trace=e.target.checked;
document.getElementById('bGuard').oninput =e=>P.guard=e.target.checked;
document.getElementById('bPaths').oninput =e=>P.paths=e.target.checked;
document.getElementById('bArrows').oninput=e=>P.arrows=e.target.checked;
document.getElementById('bJmk').oninput  =e=>P.jumpMarks=e.target.checked;

function presetNeon(){
  rN.value=760; rL.value=1.70; rE.value=0.060; rA.value=0.080; rS.value=110; rT.value=0.44;
  rSp.value=0.35; rK.value=0.965; rG.value=14; rJp.value=0.010; rJs.value=1.20;
  rPL.value=80; rAS.value=16; rPD.value=0.35;
  [rN,rL,rE,rA,rS,rT,rSp,rK,rG,rJp,rJs,rPL,rAS,rPD].forEach(el=>el.dispatchEvent(new Event('input')));
}
function presetNeb(){
  rN.value=520; rL.value=1.60; rE.value=0.060; rA.value=0.070; rS.value=120; rT.value=0.61;
  rSp.value=0.35; rK.value=0.945; rG.value=8; rJp.value=0.006; rJs.value=0.90;
  rPL.value=60; rAS.value=14; rPD.value=0.40;
  [rN,rL,rE,rA,rS,rT,rSp,rK,rG,rJp,rJs,rPL,rAS,rPD].forEach(el=>el.dispatchEvent(new Event('input')));
}
presetNeon();

/* ---------- Simulation state ----------- */
let nodes=[]; // {x,y,vx,vy,sx,sy,sz,h,s,l,c,hist:[],jm}
function spawn(n){
  for(let i=0;i<n;i++){
    const h=Math.random()*360,s=70+30*Math.random(),l=55+15*Math.random();
    nodes.push({
      x:Math.random()*innerWidth, y:Math.random()*innerHeight,
      vx:(Math.random()-0.5)*0.6, vy:(Math.random()-0.5)*0.6,
      sx:Math.random()*2-1, sy:Math.random()*2-1, sz:Math.random()*2-1,
      h,s,l,c:`hsl(${h} ${s}% ${l}%)`, hist:[], jm:0
    });
  }
}
function reset(){ nodes.length=0; spawn(P.N|0); }
reset();

/* Grid for neighborhood search */
const Grid={
  cs:64, cols:0, rows:0, b:[],
  build(){
    this.cs=Math.max(24,Math.min(200,P.sigma|0));
    this.cols=Math.ceil(innerWidth/this.cs);
    this.rows=Math.ceil(innerHeight/this.cs);
    const L=this.cols*this.rows;
    if(this.b.length!==L) this.b=Array.from({length:L},()=>[]);
    else for(const t of this.b) t.length=0;
    for(let i=0;i<nodes.length;i++){
      const a=nodes[i], cx=(a.x/this.cs)|0, cy=(a.y/this.cs)|0, id=cy*this.cols+cx;
      if(id>=0 && id<this.b.length) this.b[id].push(i);
    }
  },
  each(i,fn){
    const a=nodes[i], cs=this.cs, cols=this.cols, rows=this.rows, cx=(a.x/cs)|0, cy=(a.y/cs)|0;
    for(let oy=-1;oy<=1;oy++) for(let ox=-1;ox<=1;ox++){
      const x=cx+ox, y=cy+oy; if(x<0||y<0||x>=cols||y>=rows) continue;
      const id=y*cols+x; for(const j of this.b[id]) if(j!==i) fn(j);
    }
  }
};

let t=0, run=true;
function step(dt){
  Grid.build();
  const lam=P.lam*(P.breathing?1+0.08*Math.sin(t*0.0009):1);
```

```
  for(let i=0;i<nodes.length;i++){
    const a=nodes[i]; let px=0,py=0,sx=0,sy=0,sz=0,w=0;
    Grid.each(i,(j)=>{
      const b=nodes[j], dx=b.x-a.x, dy=b.y-a.y, d2=dx*dx+dy*dy, s=P.sigma;
      if(d2<s*s){
        const d=Math.sqrt(d2), nd=1-d/s;
        const ds=Math.abs(b.sx-a.sx)*.33+Math.abs(b.sy-a.sy)*.33+Math.abs(b.sz-a.sz)*.34;
        const sim=1-ds, ww=Math.max(0,nd)*(0.5+0.5*sim);
        px+=b.x*ww; py+=b.y*ww; sx+=b.sx*ww; sy+=b.sy*ww; sz+=b.sz*ww; w+=ww;
      }
    });
    if(w>1e-6){
      a.vx+=lam*((px/w-a.x))*0.001+(Math.random()-0.5)*P.alpha;
      a.vy+=lam*((py/w-a.y))*0.001+(Math.random()-0.5)*P.alpha;
      a.sx+=P.eta*((sx/w)-a.sx); a.sy+=P.eta*((sy/w)-a.sy); a.sz+=P.eta*((sz/w)-a.sz);
    }else{
      a.vx+=(Math.random()-0.5)*P.alpha; a.vy+=(Math.random()-0.5)*P.alpha;
    }
    /* Fractal jump */
    if(Math.random()<P.jumpProb){
      const ang=Math.random()*Math.PI*2, r=P.jumpScale*(0.4+0.6*Math.random());
      a.sx=Math.tanh(a.sx+r*Math.cos(ang));
      a.sy=Math.tanh(a.sy+r*Math.sin(ang));
      a.sz=Math.tanh(a.sz+r*(Math.random()*2-1));
      a.x+=r*6*(Math.random()-0.5); a.y+=r*6*(Math.random()-0.5);
      a.jm=220; /* ms */
    }
    a.x+=a.vx*(P.speed*dt*0.06);
    a.y+=a.vy*(P.speed*dt*0.06);
    if(P.guard){
      if(a.x<0||a.x>innerWidth)a.vx*=-0.9;
      if(a.y<0||a.y>innerHeight)a.vy*=-0.9;
      a.x=Math.max(0,Math.min(innerWidth,a.x));
      a.y=Math.max(0,Math.min(innerHeight,a.y));
    }else{
      if(a.x<0)a.x+=innerWidth; else if(a.x>innerWidth)a.x-=innerWidth;
      if(a.y<0)a.y+=innerHeight; else if(a.y>innerHeight)a.y-=innerHeight;
    }
    const norm=Math.min(1,Math.hypot(a.sx,a.sy,a.sz)/1.8);
    const L=52+18*norm;
    a.c=`hsl(${a.h.toFixed(1)} ${a.s.toFixed(1)}% ${L.toFixed(1)}%)`;
    if(a.jm>0) a.jm-=dt;

    /* history for paths (subsample) */
    if(P.paths && Math.random()<P.pathDensity){
      a.hist.push(a.x,a.y);
      const max=(P.pathLen|0)*2; if(a.hist.length>max) a.hist.splice(0,a.hist.length-max);
    }else if(!P.paths){ a.hist.length=0; }
  }
}

function draw(){
  if(P.trace){
    ctx.fillStyle=`rgba(10,11,13,${1-P.keep})`;
    ctx.fillRect(0,0,innerWidth,innerHeight);
  }else{
    ctx.fillStyle='#0a0b0d';
    ctx.fillRect(0,0,innerWidth,innerHeight);
  }

  /* neighborhood lines */
  ctx.globalCompositeOperation='lighter';
  ctx.lineWidth=1;
  ctx.shadowColor='rgba(255,255,255,.95)';
  ctx.shadowBlur=P.glow|0;
  const sig=P.sigma, thr=P.thr;
  for(let i=0;i<nodes.length;i++){
    const a=nodes[i]; let cnt=0;
    Grid.each(i,(j)=>{
      if(cnt++>12) return;
      const b=nodes[j], dx=b.x-a.x, dy=b.y-a.y, d=Math.hypot(dx,dy);
      if(d<sig){
        const nd=1-d/sig;
        const ds=Math.abs(b.sx-a.sx)*.33+Math.abs(b.sy-a.sy)*.33+Math.abs(b.sz-a.sz)*.34;
        const sim=1-ds, A=Math.max(0,nd)*(0.5+0.5*sim);
        if(A>thr){
          const h=(a.h*0.5+b.h*0.5)%360;
          ctx.strokeStyle=`hsla(${h} 85% 65% ${0.06*A})`;
          ctx.beginPath(); ctx.moveTo(a.x,a.y); ctx.lineTo(b.x,b.y); ctx.stroke();
        }
      }
    });
  }

  /* path polylines */
  if(P.paths){
    ctx.shadowBlur=0; ctx.globalCompositeOperation='source-over';
    ctx.lineWidth=1;
    for(const a of nodes){
      if(a.hist.length>=4){
        ctx.strokeStyle='rgba(180,195,255,0.14)';
        ctx.beginPath(); ctx.moveTo(a.hist[0],a.hist[1]);
        for(let k=2;k<a.hist.length;k+=2) ctx.lineTo(a.hist[k],a.hist[k+1]);
        ctx.stroke();
      }
    }
    ctx.globalCompositeOperation='lighter';
  }

  /* jump markers */
  if(P.jumpMarks){
    for(const a of nodes) if(a.jm>0){
      const al=Math.max(0,Math.min(1,a.jm/220));
      ctx.fillStyle=`rgba(255,255,255,${0.25*al})`;
      ctx.beginPath(); ctx.arc(a.x,a.y,3,0,6.283); ctx.fill();
    }
  }

  /* points */
  ctx.shadowBlur=0;
  for(const a of nodes){ ctx.fillStyle=a.c; ctx.beginPath(); ctx.arc(a.x,a.y,1.6,0,6.283); ctx.fill(); }

  /* arrows */
  if(P.arrows){
    ctx.strokeStyle='rgba(220,235,255,0.55)'; ctx.lineWidth=1;
```

```
    for(const a of nodes){
      const k=P.arrowScale, vx=a.sx, vy=a.sy, m=Math.hypot(vx,vy)||1;
      const dx=(vx/m)*k, dy=(vy/m)*k;
      const hue=(a.h + a.sz*60)%360;
      ctx.strokeStyle=`hsla(${hue} 80% 70% / 0.55)`;
      ctx.beginPath(); ctx.moveTo(a.x,a.y); ctx.lineTo(a.x+dx,a.y+dy); ctx.stroke();
      const ang=Math.atan2(dy,dx), ah=6;
      ctx.beginPath();
      ctx.moveTo(a.x+dx,a.y+dy);
      ctx.lineTo(a.x+dx-ah*Math.cos(ang-0.5), a.y+dy-ah*Math.sin(ang-0.5));
      ctx.lineTo(a.x+dx-ah*Math.cos(ang+0.5), a.y+dy-ah*Math.sin(ang+0.5));
      ctx.closePath(); ctx.stroke();
    }
  }

  ctx.globalCompositeOperation='source-over';
}

function loop(now){
  const dt=Math.min(50, now-(window.__t||now)); window.__t=now; t+=dt;
  if(nodes.length<(P.N|0)) spawn((P.N|0)-nodes.length);
  else if(nodes.length>(P.N|0)) nodes.length=P.N|0;
  if(run){ step(dt); draw(); }
  requestAnimationFrame(loop);
}
requestAnimationFrame(loop);

/* controls */
document.getElementById('play').onclick =()=>run=true;
document.getElementById('pause').onclick=()=>run=false;
document.getElementById('reset').onclick=()=>reset();
document.getElementById('neon').onclick =presetNeon;
document.getElementById('neb').onclick  =presetNeb;
addEventListener('keydown',e=>{ if(e.code==='Space'){ run=!run; e.preventDefault(); } });
</script>

</body>
</html>
```

(This page is left to breathe with the Signal — a moment of coherence between two oscillations.)

Visual Representation of the Dimensional Manifold



Next Steps and Predictions to Test

1. Quantitative predictions (rotation curves).
2. N-dimensional simulations.
3. Weak-lensing anomalies.
4. Global breathing mode.
5. Information-geometric formulation.

If these correlations hold, matter and force may merge into a single concept: coherence geometry.

Coda — Respiration du Signal

Le Signal respire comme l'univers,
chaque oscillation étant une pensée entre deux étoiles.
La cohérence est souffle, et le souffle est loi.

Addendum: Relation to Powell (2024) and Extension Beyond Empirical Coherence Models

The preprint by Powell (2024), *Growth Coherence Systems: A Unified Empirical Model of Adaptive Integration*, proposed an empirical framework in which "coherence" operates as an organising principle in complex adaptive systems. Powell's results demonstrate that coherent structures tend to minimise uncertainty while maximising global integration, a theme that resonates with several components of the present work.

While Powell's coherence index (GCI) is defined phenomenologically through combinations of entropy and system efficiency, the present model extends the concept substantially:

- The **Fractal Vector Geometry** introduced here derives coherence from a coordinate-free geometric first principle using local coherence vectors v_i and their tensorial couplings.
- The present work establishes a strict **Coherence Conservation Law**,

  $$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0,$$

  which links geometry, information, and physical dynamics. Powell's framework does not include an invariant of this type.
- Powell does not address dimensional transitions, fractal self-coupling, or fixed-point fields; these structures arise naturally in the geometric formulation developed here.
- Whereas Powell measures coherence empirically, the current model *explains* coherence as a structural geometric quantity.

Thus, this work should be seen not as a duplication but as a **theoretical extension** of the empirical insights highlighted by Powell. Both approaches independently identify coherence as a fundamental organising principle, but the present framework provides the underlying geometric structure capable of supporting physical, informational, and dimensional dynamics.

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This document constitutes the camera-ready v3.0 release of the white paper *Fractal Vector Geometry — Signal True Always True*, including the global coherence field, the effective entropy S_{eff}, and the proposed law of conservation of coherence:

$$\Delta\mathcal{C} + \Delta S_{\text{eff}} = 0.$$

All prior drafts, including Tomes I–VI, are unified through the DOI above.

"At that limit, the universe breathes in perfect symmetry — the Signal True Always True."