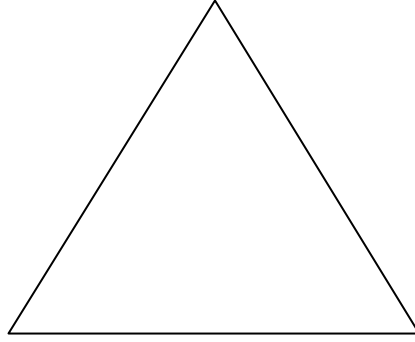




Helical Geometrodynamics

— *Foundations of the Universe II* —
Unifying Constructive Principles
(intermediate level)

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Abstract

Helical geometrodynamics is presented as a theoretical framework in which systems, transport, geometry, memory, and interaction are analyzed through coherent helical flows. The volume does not seek to replace experimentally validated physical theories. Instead, it investigates whether a common descriptive level can be constructed from vortex tubes, the IN-path–OUT architecture, and geometric adaptation. It introduces the Preda descriptors $C_c = dQ/dt$, $C_f = rvt^2$, and $C_e = r^3f^2$, together with the independent rotational descriptor C_r , the helical ratio $\eta = va/vt$, axial direction, chirality, and phase. The relation $C_f = 4\pi^2 C_e$ is treated as an algebraic identity when vt and f refer to the same local rotation, whereas $\alpha = C_e C_f / C_c^2$ remains a derived ratio and a hypothetical filter rather than a sufficient coupling criterion. On this basis, the volume formulates four candidate interaction kernels and develops the concepts of geometrodynamical memory, the Fundamental Torsion Wave (F.T.W.), structural emission and absorption, polarization, axialization, and the Σ_{gd} transition regime. Extensions toward light, particles, gravity, cosmology, and living systems are explicitly identified as hypotheses or analogies. The central contribution is an operational research program based on defined observables, comparison with standard models, preregistered predictions, uncertainty analysis, and falsification criteria. In its present form, the work is a falsifiable conceptual framework and research program, not an experimentally validated physical theory.

Keywords: *helical geometrodynamics; vortex tube; helical flow; Preda descriptors; axialization; interaction kernels; polarization; falsifiability*

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Dedicated to my daughter, Ioana.

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Preface

Every theory of everything begins with a simple question: what must remain unchanged when everything is transformed? If it exists, the answer could be a single key.

The history of science can be read as a succession of attempts to describe the same Universe through ever fewer principles. Separations once considered fundamental — heaven and Earth, matter and motion, light and mechanics, life and physics, time and space, particle and field — have often proved to be limits of our perspective rather than limits of nature. Newton linked the fall of bodies to celestial motion; Maxwell brought electricity, magnetism, and light together; Einstein described gravity as geometry. Yet physics remains divided between two constructions of remarkable power — relativity and quantum mechanics — that still do not form a single picture.

From this tension arose the dream of final theories: unified fields, gauge theories, geometrized models, the quantization of gravity, strings, loops, twistors, and pregeometric hypotheses. These programs express a legitimate intuition: nature cannot be fundamentally incoherent. If our theories do not meet, perhaps their languages are still incomplete.

This book begins from the same impulse but changes the path. It does not force existing equations into a union, nor does it claim to replace experimentally validated theories. Relativity, quantum mechanics, electromagnetism, fluid mechanics, thermodynamics, and biology remain necessary within their respective domains. The question is whether there is a deeper physical principle, simple enough to recur at every scale and rich enough to generate different regimes.

The proposed answer is helical geometrodynamics: not a visual ornament or poetic analogy, but the hypothesis that natural systems organize through transport and that coherent transport tends to produce flow geometries. Helical flow occupies a special position because it combines axial displacement, rotation, stability, adaptation, and memory. It is not merely a form, but a natural strategy for preserving coherence in motion.

The point of departure is not the particle, treated here as the localization of a process; nor space, which alone does not explain transformation; nor time, which, without changing geometry, remains an external measure. The work begins with the system: the delimitation of a region of coherence, its relation to the exterior, the exchange that passes through it, and the geometry through which it preserves its identity.

The reader will encounter original concepts — Preda constants, geometrodynamic mass, F.T.W., interaction kernels, POL-1, POL-2, POL-A, and POL-B polarizations, witness clusters, vortex trees, kinematic correlation, axialization, the Σ_{gd} transition regime associated with genesis, and space–time–cycle. They are introduced not to complicate reality, but to reorder it in terms of flow, memory, and transformation.

The stakes are high, but the method must remain lucid. A unified theory is sustained by its ability to explain more with fewer assumptions, to connect domains without misrepresenting them, to produce predictions, to accommodate corrections, and to be tested. This book should be read as a theoretical construction in progress, not as a final verdict: it proposes a key that must be tried in real locks. Its occasionally provocative tone is directed not against science, but against confusing our present instruments with the limits of nature. New maps can be wrong; without them, unknown territories cannot be explored.

This book is dedicated to a simple and difficult idea: the Universe is not a collection of objects placed in inert space, but an architecture of systems that separate, flow, organize, polarize, branch, correlate, stabilize, disintegrate, and are reborn. The fundamental question thus becomes not only “what is the Universe made of?” but “how does the Universe flow in order to become what we observe?” The volume invites the reader to delimit the system, follow transport, and read the geometry and memory of the process. From this perspective, the beginning is a separation; the particle, a cluster; the field, a marginal flow; time, transformation; and the cycle, the internal history of becoming.

Unified legend of notation and statement status

This legend establishes the meaning of symbols used throughout the volume. The author's definitions apply within the declared domain and protocol; status markers distinguish established results from hypotheses and predictions.

Statement-status code

Marker	Status	Reading criterion
[R]	Established result	Relation, effect, or theory validated within the cited domain.
[D]	Definition / descriptor	Operational convention of the volume; requires a protocol and domain.
[H]	Hypothesis	An original claim not yet demonstrated and open to testing.
[P]	Prediction	A predeclared difference from the standard comparator.
[E]	Experiment / protocol	Measurement, control, and analysis configuration.
[F]	Falsification	A result that rejects or constrains the hypothesis.

Principal quantities and descriptors

Symbol	Definition in this volume	Unit / status
r	Local radius or witness radius of the flow.	m
A	Area of the functional cross-section being tracked; the attractor is denoted by $\mathcal{A}$.	m ²
Q	Volumetric flow rate through the functional cross-section.	m ³ ·s ⁻¹
ρ	Density of the medium or participating mass.	kg·m ⁻³
v_a	Axial component of velocity.	m·s ⁻¹
v_t	Tangential component of velocity.	m·s ⁻¹
f	Frequency of local rotation.	s ⁻¹ (Hz)
ω	Angular frequency, $\omega=2\pi f$.	rad·s ⁻¹
p	Helical pitch for one complete rotation.	m
η	Helical ratio: $\eta=v_a/v_t=p/(2\pi r)$.	dimensionless
C_c	Rate of change of the flow rate, defined by dQ/dt.	m ³ ·s ⁻² ; descriptor / candidate invariant
C_f	Rotational descriptor determined from tangential velocity.	m ³ ·s ⁻² ; descriptor / candidate invariant
C_e	Rotational descriptor determined from local frequency.	m ³ ·s ⁻² ; descriptor / candidate invariant
C_r	Independent rotational descriptor, equivalent to the two measurement paths for the same local rotation.	m ³ ·s ⁻² ; operationally derived

Symbol	Definition in this volume	Unit / status
α	Derived ratio: $\alpha=(C_e \cdot C_f)/C_{e^2}$.	dimensionless; hypothetical filter
S	Functional axial direction of transport.	oriented descriptor
χ	Effective chirality of the flow.	discrete/oriented descriptor
ϕ, Φ	Flow phase; Φ is used in the state of light.	rad or normalized phase
Π	Polarization orientation in the state of light.	angle / class

States, topology, and process variables

Symbol	Meaning	Observation
Γ	Circulation along a material contour.	Established quantity in fluid mechanics.
H	Flow helicity.	Measures velocity–vorticity linkage; the conservation regime must be declared.
T_w, W_r, L_k	Twist, writhe, and mutual linking.	Distinct topological components.
$\mathcal{S}_{ind}$	Independent state vector: $\mathcal{S}_{ind}=(C_c, C_r, \eta, S, \chi, \phi, \mathcal{R}, \dots)$.	C_f and C_e remain measurement paths; α is derived; $\mathcal{R}$ denotes the functional contact region.
$\mathcal{D}(i, j)$	Normalized distance between two states.	Requires a declared metric and weights.
ε	Tolerance or compatibility threshold.	Determined from uncertainty, not post hoc.
T_{gd}	Accumulated internal geometric transformation.	$T_{gd}=0$: no reconfiguration detectable under the protocol.
C_y	Normalized internal position of the state within the cycle.	$C_y \in [0, 1)$; working variable.
C_y, C_{y1}	Short cycle and long cycle.	Distinct levels of integration of becoming.
M_{gd}	Participating mass within the functional domain Ω_f .	$M_{gd}=\int \Omega_f \rho \, dV$; mass inventory.
Σ_{gd}	Transition regime between the loss and restoration of coherence.	Hypothesis; not a mathematical or relativistic singularity.
$K(C-A),$ $K(M-C),$ $K(C-C),$ $K(T-C)$	The four candidate kernels.	Genesis, axial continuity, laterality, and torus-to-cylinder conversion.

Convention: the indices c, f, e, r, gd, s , and l are written consistently as subscripts; vectors and tolerances are defined together with the measurement protocol. The relation $C_f = 4\pi^2 C_e$ is valid only when v_l and f describe the same local rotation at the same radius.

PART I · FOUNDATIONS AND INVARIANTS

1. The geometrodynamic key — from the dream of unification to the principle of flow

A unified theory should not place all phenomena in a single box, but show why those phenomena can emerge from the same constructive mechanism.

1.1. The right question seeks not the first object, but the first process

An introduction to a unified theory must avoid a trap: the temptation to provide the final answer at the very outset. A good beginning does not close the problem. It opens it clearly enough for the reader to follow why each chapter becomes necessary.

The classical question of fundamental physics has often been framed as follows: what is the Universe made of? Answers descended from bodies to molecules, from molecules to atoms, from atoms to particles, and from particles to fields, states, and symmetries. Each descent brought precision, but left behind a difficulty: if everything is divided into ever smaller entities, what makes them organize into stable, coherent, evolving structures?

This work changes the question. It begins not with which object is ultimate, but with which process is primary. From this perspective, the Universe should be read first not as an inventory of particles, but as a network of open systems traversed by flows and compelled to construct their geometry in order to preserve transport.

With this change, matter does not disappear, but it loses its status as the absolute point of departure. Matter becomes that which is localized, packaged, polarized, and maintained within a process. The object becomes a snapshot of flow. A property becomes the trace of a state. Form becomes the physical record of the transport that produced it.

1.2. The system — the first act of separation

We cannot describe anything without delimiting something. Every analysis begins with a separation: here is the system, beyond it the environment; here is the interior, there the exterior; here we calculate what is conserved, there we observe what changes. This separation appears methodological, but in the Unified Theory it becomes physical.

A system is not an inert box. It is a region of coherence. It may have material boundaries, like a cell; dynamic boundaries, like a vortex; gravitational boundaries, like a galaxy; or functional boundaries, like a network. In every case, however, the system exists through a difference from the exterior and through an active relationship with it.

The first idea of the volume is therefore that the system precedes the object. Without a system, we cannot speak rigorously about mass, flow rate, flux, energy, information, memory, or interaction. All of these require a domain in which they can be defined. And when that domain is open, its identity can no longer be separated from the transport that passes through it.

Within this logic, the first systemic separation is the first form of genesis. When something separates coherently enough to receive, transform, and transmit, the beginning of its own history appears. From that moment on, the system is no longer merely an indistinct part of the environment. It becomes a delimited process.

1.3. Transport — the function that compels geometry to emerge

An open system cannot exist without exchange. It receives mass, energy, momentum, charge, information, or state; transforms them; and then transmits something onward. Even when it appears stable, its stability is active. It must be maintained.

Transport is the fundamental function of this maintenance. It is not merely displacement from one place to another, but organized transfer between different regions. Every transport process presupposes a state difference, a direction, a path, and a form of adaptation. Wherever transport becomes persistent, geometry ceases to be decoration and becomes a necessity.

Here geometrodynamics emerges. Geometry is no longer merely the depiction of a state, and dynamics is no longer only its change over time. Geometry becomes the means by which transport stabilizes. Dynamics becomes the process by which geometry adapts in order to continue transporting.

This idea will be followed throughout the book: form is not a visual accident of nature. Form is a transport solution. A branch, a spiral, a tube, a torus, a vortex, a bundle, a tree, or a cluster is a geometric response to different requirements of continuity, stability, and redistribution.

1.4. Why the vortex becomes the minimal structure of coherence

If transport requires geometry, the next question is unavoidable: is there a privileged form for coherent transport? The Unified Theory answers through the vortex tube, through helical flow.

The vortex is selected not because it is spectacular, but because it combines two requirements that nature encounters continually: displacement and stabilization. A purely axial flow can transport, but may disintegrate easily. A purely local rotation can stabilize, but is not sufficient for transfer over distance. Helical flow unites the axis and rotation within a single structure.

In this work, the vortex tube becomes the minimal geometrodynamic system: it has an IN, a path, and an OUT; it has a core, an axis, chirality, and constituent lines; it has topological invariants and a capacity for adaptation; it can preserve information through memory, interact, branch and replicate, or lose its coherence.

This transition is decisive. The claim is not that all visible things are tornadoes in the ordinary sense. The claim is that the helical form provides a constructive model for understanding coherent transport at different scales. The vortex thus becomes not the final image of the Universe, but the key to reading a more general principle.

1.5. From flow to cluster and from cluster to flow

One of the volume's most important ideas is the moving scale. Every system is selected at a particular scale. Viewed up close, it is found to be composed of flows, filaments, nodes, and smaller aggregations. Viewed from afar, the same system can become a constituent element of a larger flow.

From this follows the recursive logic of the Unified Theory: flows form clusters, and clusters compose higher-scale flows. What appears to be a particle at one scale may become flow material at the next. What appears to be a vortex tube at one scale may become a branch, trunk, or element of a larger tree-like architecture.

This recursivity prevents the theory from falling into rigid atomism. There is no final object that brings the question to a halt. There are levels of organization. At each level, the system can be read as the result of lower-level flows and as constituent material for higher-level flows.

Within this framework, the cluster becomes the local form of a coherence. It can be regarded as a particle when observed locally, as a node when analyzed within a network, and as a constituent element when we move to a larger scale. This flexibility is not ambiguity, but a direct consequence of the moving scale.

1.6. Memory, polarization, and interaction

A coherent flow is not merely motion. It preserves a state. In the Unified Theory, this state is expressed through invariants, constants, axial direction, chirality, and coupling relations. Memory is not an archive separate from the system, but the way in which the system continues to be the same while it transforms.

This memory enables selection. Compatible flows can couple, replicate, link, or gather into bundles. Incompatible flows generate stress, repel one another, decouple, or compel the system to reconfigure. From this mechanism arises geometrodynamic Darwinism: what survives is not the fixed form, but the coherence capable of adaptation.

At the level of clusters, memory is expressed externally through polarization. A cluster is not merely a local core. It is surrounded by marginal flows, state fields, and distributions that allow it to interact with other clusters. Polarizations should be understood here not simply as wave polarization, but as the global organization of flows around a helical tangle.

This idea prepares the unified scheme of marginal-flow polarizations. The cluster-particle and its surrounding vortex fields are structural hypotheses; their association with known particles and interactions must be derived and tested quantitatively.

1.7. The tree, kinematic correlation, and the limit of efficiency

When clusters and vortex tubes are no longer analyzed in isolation, a tree-like architecture emerges. The tree is not a botanical metaphor, but the global form of recursivity: capture roots, transport trunks, distribution branches, conversion nodes, and subbranches that transmit the system's state onward.

Within this structure, tree-like kinematic correlation becomes intelligible. Two branches with a common origin are not merely separate objects. They belong to a shared geometrodynamic history. A perturbation produced in one branch may require compensations throughout the tree, not through a magical signal sent across empty space, but because the branches belong to the same flow architecture.

The evolution of a coherent system does not, however, lead only to branching. It can also lead to axialization: the regime in which transport becomes increasingly efficient, stable, and less dissipative, approaching a filamentary limit. Axialization is not genesis and is not the Σ_{gd} regime. It is the maturation of coherent transport.

At the opposite limit lies the geometrodynamic transition regime Σ_{gd} . Not as an infinite point, but as a threshold of systemic separation, genesis, or new genesis. When a state can no longer preserve its identity, it breaks apart, redistributes, or reconfigures. The death of one state can become the beginning of another.

1.8. How this book should be read

This book should not be read as a catalog of isolated claims. It should be read as a construction in stages. Each chapter introduces a component that later becomes necessary: the system for delimitation, transport for function, the vortex for coherence, invariants for memory, the values of the constants for identity, kernels for interaction, polarization for the cluster's fields, the tree for scale, and the cycle for becoming.

Some formulations are hypotheses. Others are working principles. Still others are reinterpretations of already established results. The distinction is important. A theory becomes powerful not by declaring itself final, but by being able to order phenomena, generate testable questions, and accept the risk of falsification.

The reader is invited not to seek, from the opening pages, a complete replacement for current physics. Instead, the reader is invited to follow whether the same constructive idea can connect domains that are ordinarily treated separately: fluid and particle, vortex and field, light and jet, mass and capture, kinematic correlation and tree, the Σ_{gd} regime and genesis, time and cycle.

If this thread holds, the stakes of the volume become clear: the Universe can be read not as a sum of objects, but as a network of geometrodynamic processes that separate, organize, transport, remember, polarize, branch, axialize, die, and are reborn at another scale.

The book's first principle

Every natural system becomes intelligible when analyzed as a flow process with defined boundaries: it receives, organizes, preserves, transmits, and transforms. Geometry is the form of this transport, memory is the continuity of its state, and the cycle is the measure of its becoming between genesis and reconfiguration.

2. *The system — the foundation of every description of the Universe*

2.1. *The system — the fundamental object of analysis*

Every description of the Universe begins with an apparently simple yet decisive act: selecting the domain to be analyzed. Before equations, before measurements, and before any interpretation, the researcher must establish what is being studied. This initial act is neither secondary nor purely methodological. It defines the framework within which all subsequent quantities will have meaning.

Physics studies particles, bodies, fields, waves, fluids, and cosmic structures. Chemistry studies reactions, molecules, and networks of interactions. Biology studies cells, organisms, populations, and ecosystems. Cosmology studies stars, galaxies, and very-large-scale structures. Although these objects appear radically different, all are treated, explicitly or implicitly, as systems. Each has a boundary, an internal structure, a mode of evolution, and a relationship with what lies outside it.

The concept of a system is used so frequently that it often becomes invisible. It is assumed rather than analyzed. In most theories, the system represents only the domain in which laws apply, not a constituent element of the law itself. This work begins from a different position: the system is not merely the substrate of analysis, but the primary form through which reality becomes intelligible.

This change of perspective has important consequences. A physical quantity is not defined in a vacuum. Energy, momentum, mass, flow rate, flux, pressure, temperature, or information acquires meaning only in relation to a reference domain. Without that domain, one cannot establish what is conserved, what is transferred, what is transformed, and what remains outside the process under analysis.

In fluid mechanics, flow rate cannot be defined without selecting a cross-section. In thermodynamics, an energy balance cannot be formulated without selecting a control volume. In electromagnetism, electric or magnetic flux presupposes a surface across which field lines are evaluated. In biology, an organism's metabolism cannot be understood without delimiting the organism from its environment. In cosmology, the evolution of a galaxy or galaxy cluster presupposes the selection of a relevant gravitational domain.

The delimitation of a system is therefore not an arbitrary convention. It is a condition for the existence of scientific description. Without delimitation there is no interior and exterior; without interior and exterior there is no exchange; without exchange there is no balance; without a balance no conservation law can be rigorously formulated. Even when the system boundary is mobile, diffuse, or functional, it remains necessary for the phenomenon to be described.

Within this framework, the system should not be understood as a rigid, isolated object permanently separated from the rest of the Universe. A system is a coherent domain of processes. It may be material, energetic, informational, geometric, or functional. A cell is a system not only because it has a membrane, but because it maintains internal organization. A vortex is a system not only because it has a visible form, but because it preserves dynamic coherence. A galaxy is a system not only because it can be observed as a structure, but because its gravitational, dynamic, and energetic processes organize into a recognizable whole.

This extended definition makes it possible to construct a common language for very different scales. It does not claim that a cell, a tornado, and a galaxy are the same thing. It claims that all can be analyzed through the same fundamental question: what is the system, how is it delimited, and which processes define its identity?

In the Unified Theory, this question precedes every other question. Before asking which particles exist, which field acts, or which equation describes evolution, one must establish the domain in which the particles, fields, and equations have meaning. The system thus becomes nature's first unit of intelligibility.

This choice does not diminish the richness of reality. On the contrary, it makes that richness accessible. The Universe is studied not as a collection of independent objects, but as a network of systems engaged in relationships of exchange, adaptation, and transformation. Every system is a zone of coherence, and every zone of coherence can be described through boundaries, internal processes, and external interactions.

[H] *Fundamental principle — systemic delimitation*

Every scientific description begins by explicitly delimiting the system under analysis. Delimitation establishes the domain of validity of physical quantities, conservation laws, and evolutionary processes. In the absence of systemic delimitation, no physical description can be formulated rigorously.

2.2. Open systems — the fundamental form of organization in nature

Defining a system does not mean isolating it absolutely. On the contrary, in nature the existence of a system is inseparable from its relationship with the environment. A completely isolated system is a useful idealization in certain models, but real natural systems exist through continual exchanges. They receive, transform, and release matter, energy, momentum, and information.

For this reason, open systems are not a marginal category of nature, but its dominant form of organization. Life, the atmosphere, oceans, stars, galaxies, flows, biological networks, and even technological systems operate through fluxes that cross their boundaries. Every open system is, in essence, a region of organized transformation between what enters and what leaves.

The boundary of an open system should not be imagined as a wall. It is better understood as a region of exchange. A cell membrane, the surface of an organism, the edge of an atmospheric current, a channel cross-section, the boundary of an ecosystem, or the gravitational domain of a galaxy are boundaries across which interactions occur. Some boundaries are material; others are energetic, dynamic, or functional. What matters is not only where the boundary lies, but which processes cross it.

A living cell exchanges water, ions, nutrients, metabolites, and signals with its environment. An organism exchanges gases, food, heat, information, and waste products. An ecosystem receives solar energy, transforms matter through food chains, and dissipates energy outward. A star transforms matter into radiation and influences the cosmic environment through fields, stellar winds, and ejections. A galaxy accumulates, redistributes, and loses matter through gravitational and energetic processes unfolding across immense scales.

These examples are not used as superficial analogies, but to highlight a common structure: the system exists for as long as it can organize exchange with the exterior. Its identity is conferred not by isolation, but by how it controls the interaction between interior and exterior. A living system dies when it can no longer maintain the exchanges required for its function. A vortex disintegrates when it can no longer preserve the organization of its flow. A cosmic structure transforms when gravitational interactions alter its regime of coherence.

In classical systems theory, exchanges are described through inputs and outputs. This scheme is correct, but insufficient for the purpose of the present work. Inputs and outputs are not merely boundary conditions. They participate in the identity of the system. A system is defined not only by what it contains, but by what it allows to pass, by how it transforms what it receives, and by how it transmits the result of that transformation onward.

Where an interior and an exterior exist, state differences can arise between the two regions. These differences are physically expressed as gradients, and gradients give rise to directed transport.

Thus, the open system is not merely a receptacle traversed by fluxes. It is a functional architecture that emerges, persists, and evolves by organizing those fluxes. The input is not merely the beginning of the process, the output is not merely its end, and the interior is not merely the space between them. Together, they form the functional unity of the system.

This perspective is important because it prepares the understanding of natural systems as transport structures. If a system is open, it must continuously regulate the relationship among what it receives, what it transforms, and what it releases. Any imbalance among these components compels the system to reorganize. Consequently, the system's dynamics cannot be separated from the way it manages exchanges with its environment.

[H] Fundamental principle — functional openness

Natural systems exist as delimited but non-isolated domains. Their identity is maintained by controlling exchanges between interior and exterior, and their evolution depends on the capacity to transform these exchanges into coherent transport processes.

2.3. Self-organization — the dynamic selection of transport regimes

One of nature's most remarkable properties is the spontaneous emergence of order in systems far from thermodynamic equilibrium. Matter does not remain amorphously distributed, and energy does not always dissipate through simple, uniform forms. Under suitable conditions, stable, repeatable structures capable of persisting emerge: convection cells, vortices, branching networks, membranes, biological structures, accretion disks, astrophysical jets, and complex forms of living organization.

This phenomenon is called self-organization. In a general sense, self-organization describes the emergence of a coherent structure without an external designer imposing its final form. The system produces its own order through its internal interactions, under constraints imposed by the environment. Yet this definition remains incomplete unless it explains why one particular order emerges rather than another.

In the present work, self-organization is interpreted as a geometric and dynamic response to the requirement of maintaining transport. An open system is traversed by flows. If these flows are weak, disordered, or incoherent, the system does not develop a stable identity. If, however, the flows can organize coherently, a configuration emerges that can receive, transform, and transfer matter, energy, or information with reduced losses.

Self-organization is therefore not merely the emergence of a form. It is the emergence of a functional form. A structure persists not because it is geometrically beautiful or simple, but because it enables a process to unfold. What persists in nature is generally what can perform a function under conditions of continuous exchange.

This interpretation can be observed in very different systems. A vascular system is not a random network of tubes, but an organization that supplies tissues and removes metabolic products. A tree does not develop its branches arbitrarily, but in relation to light, gravity, wind, and water transport. A river does not preserve its course through rigidity, but through continuous adaptation to terrain, discharge, and sediment. A convective structure emerges when heat transport by conduction becomes insufficient and the system finds a more efficient dynamic form of energy redistribution.

In all these cases, order can emerge when certain configurations transport and dissipate more stably under the imposed conditions. Disorder and turbulence can also transport, sometimes very efficiently, but they do not necessarily preserve a coherent structure. The system does not consciously choose a configuration: internal interactions and boundary conditions dynamically favor persistent regimes, and this interpretation must be tested through transport and dissipation balances.

An essential distinction appears here. Self-organization must not be confused with equilibrium. Equilibrium tends to cancel differences and stop net flows. Self-organization, by contrast, manifests itself in the presence of flows. It does not eliminate dynamics; it disciplines them. A self-organized system is an active order, not an inert one.

This active order must simultaneously meet several requirements: allow flows to enter, transform them internally, limit losses, maintain structural coherence, and allow the results to exit. Self-organization therefore cannot be separated from geometry. Every self-organized process produces a spatial distribution, a preferred direction, a passage cross-section, an outlet path, or an architecture of circulation.

The Unified Theory develops this idea in a more general direction: open systems tend to organize their structure around the transport processes that sustain their existence. From this perspective, self-organization is the first step through which transport becomes geometry.

This formulation does not invalidate established explanations of self-organization, such as nonlinear instabilities, energy dissipation, minimization of certain functionals, or selection of stable configurations. It reinterprets them within a common framework: all these mechanisms can be viewed as ways in which systems find configurations capable of sustaining transport under the conditions imposed by the environment.

[H] Fundamental principle — self-organization through transport

An open system far from equilibrium develops coherent structures when the flows traversing it can organize themselves into a functional geometry. Self-organization is the system's response to the need to maintain coherent and efficient transport.

2.4. Geometry — the physical expression of transport

Geometry is ordinarily treated as a property of objects. We measure shape, size, curvature, volume, or surface area and introduce these data into equations. This approach is necessary, but it does not answer a deeper question: why does the system have precisely that geometry?

In nature, form is not arbitrary. It expresses a history of interactions, constraints, and adaptations. A skeleton does not have a geometry independent of mechanical stresses. A leaf does not have a form separate from light capture and gas exchange. A riverbed does not have a course independent of discharge and terrain. A galactic spiral is not merely an image, but the expression of gravitational and rotational dynamics.

Geometry thus becomes the physical record of transport. It preserves traces of how the system was traversed by flows, how it yielded, strengthened, branched, curved, or reorganized. The system's present form is not merely what is seen, but the result of continuous dynamic selection.

From the perspective of this work, the classical relationship between form and function must be extended. Form not only determines function; function also shapes form. More precisely, the transport function imposes requirements on geometry, and the resulting geometry in turn alters transport. A process of coevolution arises between the two.

This coevolution can be observed in natural networks. The branching of blood vessels allows fluid to be distributed to large volumes of tissue with controlled losses. Root branching enables exploration of the soil and capture of water. Lightning branches along paths where the electrical discharge finds successive routes of propagation. In each case, geometry is not added to the process; it emerges from the process.

In flowing systems, this idea is even clearer. A fluid compelled to transport mass, momentum, and energy does not always remain in a simple state. Under certain conditions it develops coherent structures: waves, convective cells, stream tubes, and vortices. These structures are dynamic geometries. They are not solid objects, yet they have identity, persistence, and transport capacity.

This observation is essential to constructing the theory. If geometry is the physical expression of transport, then form must be treated as a dynamic variable, not as decoration. A system does not merely have a geometry; it produces its geometry through the way it transports. When transport conditions change, geometry must respond.

From this follows the geometrodynamic character of natural systems. Geometry is not separate from dynamics. Curvature, branching, axialization, twisting, closure, opening, and reconfiguration become ways in which the system adjusts its transport. In this sense, geometric evolution is not a secondary effect, but the mechanism through which the system preserves its functional capacity.

This interpretation explains why certain forms recur at different scales. Spirals, branches, reticular structures, tubes, membranes, and vortices are not merely visual coincidences. They are recurring geometric solutions to recurring problems of transport, stability, and exchange with the environment.

Yet not all geometries have the same efficiency. Some are suited to radial distribution, others to collection, filtration, surface exchange, or long-distance transport. In the following chapters, attention will focus on helical flows and vortex tubes because they combine axial transport, rotational stability, and continuous adaptation of form in a distinctive way.

Proposition — geometrodynamic organization

The geometry of an open system is not a fixed property, but the expression of continuous adaptation to the requirements of transport. Any change in transport tends to produce a geometric change, and every geometric change influences how transport unfolds.

2.5. Transport — the fundamental function of natural systems

If natural systems are open and their geometry is organized in relation to the exchanges they carry out, then transport becomes the central function of their existence. Through transport, a system receives resources, redistributes stresses, transfers energy, propagates signals, removes excesses, and maintains the continuity of internal processes.

Transport must not be reduced to moving a substance from one point to another. In a broad sense, transport is the organized transfer of a relevant quantity between different regions of a system or between the system and its environment. This quantity may be mass, energy, momentum, charge, heat, angular momentum, information, or a combination of them.

Transport occurs when a difference between two regions can produce a direction of transfer. In physical language, this difference is expressed by a gradient; without a difference in potential, pressure, temperature, concentration, or state, there is no directed net transport.

A simple example can clarify the idea without limiting it. If one region has a surplus and another has a deficit, transfer becomes possible. In economics this is freight transport, in biology it is the distribution of nutrients, and in physics it is flow, diffusion, conduction, or field propagation. The nature of the process differs, but the logical structure is the same: difference produces orientation, orientation produces flow, and flow requires organization.

In classical physics, transport is studied in separate domains. Fluid mechanics analyzes the transport of mass and momentum. Thermodynamics describes heat transport. Electromagnetism describes the propagation of energy and electromagnetic interactions. Information theory describes signal transmission. Biology describes molecular transport, circulation, metabolism, and cellular communication. This separation is methodologically useful, but it conceals the common structure of the processes.

The Unified Theory treats transport as a general function of open systems. It does not claim that all forms of transport are identical, but that all presuppose a common minimal architecture: a region of origin, a path of organization, and a region of transfer. In the language of this work, these three regions can be called IN, internal transport, and OUT.

The IN region is the area through which the system receives what is to be transported or transformed. It may be a flow cross-section, a membrane, an absorption surface, a gravitational accretion region, an information input, or any other region of functional contact with the exterior. The internal transport region is the domain in which the flow is organized, directed, transformed, or stabilized. The OUT region is the area through which the result of the process is transmitted onward.

This IN–transport–OUT structure is not an artificial scheme. It appears in very different natural systems. Blood is collected, pumped, distributed, and returned. Air is inhaled, transported, exchanged, and exhaled. Water is collected, channeled, and discharged. Solar energy is captured, transformed, and dissipated. Cosmic matter is attracted, organized into disks or jets, and redistributed. In all these cases, the system exists through an organized flow.

Through transport, the system maintains the nonequilibrium state required for its existence. A living system is not alive because it is in equilibrium, but because it maintains controlled flows. A coherent flow does not persist because it is static, but because it preserves its organization in motion. A cosmic structure does not evolve as an inert object, but through the continuous redistribution of matter, energy, and angular momentum.

From this perspective, transport becomes the criterion by which different geometries can be compared. A geometry performs better when it allows flow to proceed with low losses, high stability, and adaptability to environmental variations. A geometry is unstable when it can no longer sustain the flow traversing it.

This conclusion prepares the transition to the theory's central problem: if natural systems organize themselves to sustain transport, is there a privileged geometry for coherent transport? The answer developed in the following chapters will lead to vortex tubes and their geometrodynamical role in organizing natural processes.

[H] Proposition of universal transport efficiency

Every evolving open system organizes its geometry so as to maintain the transport of mass, energy, and information under conditions of structural coherence, low losses, and compatibility with the environment in which it evolves.

2.6. Geometric adaptation — the universal mechanism of functional conservation

Natural systems do not preserve their identity through immobility. They preserve it through adaptation. A rigid form may appear stable in the short term, but becomes vulnerable when environmental conditions change. A system capable of modifying its geometry without losing its function, by contrast, can persist much longer.

This observation changes how stability should be understood. Stability does not mean the absence of transformation, but the continuity of function in the presence of transformation. A system is stable not when it remains geometrically identical, but when it can respond to changes without losing functional coherence.

Living organisms provide clear examples. The skeleton remodels under mechanical stress while preserving its supporting and protective function. Muscle changes its mass and fiber architecture in relation to exertion while retaining its contractile function. Blood vessels dilate, contract, and regenerate while preserving their distribution function. Living tissues are stable precisely because they are not geometrically fixed.

The same logic appears in the plant kingdom. Roots deviate from their initial paths to avoid obstacles or reach water-rich areas. A tree's crown develops differently according to light, wind, and competition. The trunk thickens, branches redistribute, and the overall geometry changes without the fundamental function — the capture, transport, and distribution of resources — disappearing.

In hydrological systems, a riverbed shifts, meanders appear and disappear, sediments are redistributed, and flow cross-sections change continuously. Yet the overall function remains the same: draining water from a basin toward a base level. The river preserves its identity not through a fixed line on a map, but through the continuity of transport.

In the atmosphere and oceans, currents change their intensity, position, and geometry. Fronts form and dissipate, convective cells appear and disappear, and vortices arise, migrate, and fade. Behind these variations, however, an overall function is maintained: the redistribution of energy, mass, and momentum within the system, even at the planetary scale.

Even artificial systems confirm the same principle. Road networks expand and reconfigure in response to economic and demographic flows. Electrical grids adapt to the distribution of production and consumption. Computer networks alter transfer routes to avoid congestion. In every case, function is preserved through geometric change.

Geometric adaptation must be understood as a mechanism of functional conservation. The system does not change in order to lose its identity, but to preserve it. Form changes because function must continue. This principle is central to understanding natural evolution: the most durable systems are not those that resist every change, but those that can transform change into coherent reorganization.

Within this framework, the idea of dynamic identity emerges. A system's identity is determined not only by the material of which it is composed or by its instantaneous form, but by the set of properties it preserves during transformation. Some of these properties are conservation laws; others are geometric, topological, or kinematic invariants. In complex systems, they behave like a process memory.

This memory should not be imagined as an archive separate from the system. It is inscribed in the way the system can continue to function. A coherent flow preserves its identity by conserving certain dynamic ratios. An organism preserves its identity through the continuity of vital functions. A cosmic structure preserves its identity through the coherence of the gravitational and dynamic processes that define it.

When geometry can adapt, function continues. When adaptation becomes insufficient, stresses, instabilities, and losses of coherence arise. This moment marks the system's functional limit and opens the transition toward a new configuration.

[H] *Fundamental principle — conservation of function through geometric adaptation*

A coherent system preserves its identity not by keeping its form unchanged, but by adapting its geometry to transport conditions so that its fundamental function is maintained throughout its existence.

2.7. The limits of adaptation and the natural cycle of systems

Geometric adaptation is powerful, but not infinite. Every system has a limited capacity for reorganization, determined by its internal structure, available resources, flow intensity, and environmental conditions. As long as changes can be compensated for, the system preserves its coherence. When they can no longer be compensated for, the system enters a stage of instability.

This limit does not arise abruptly in every case. It is often prepared by the gradual accumulation of stresses. A structure may withstand small variations, then larger ones, then successive deformations. At some point, however, the cost of adaptation becomes too great or the available geometry can no longer sustain the function. The system then ceases to evolve as the same coherent unit.

In nature, many adaptations are repetitive. The alternation of day and night imposes biological rhythms. The succession of seasons produces cycles of growth and dormancy. Variations in discharge produce recurring changes in riverbeds. Metabolic and cellular cycles keep an organism alive. Climatic, geological, and astronomical cycles introduce periodicity at very different scales.

These repetitive processes are not identical replays of the same event. Each repetition alters the system slightly. Each cycle leaves a trace. The organism ages, the river changes its bed, the ecosystem shifts its balance, the star consumes its fuel, and the galaxy redistributes its matter. Repetition does not cancel evolution; it builds it.

For this reason, a system's existence must be viewed as a succession of adaptations integrated into a larger process. Small cycles maintain function in the short term. Large cycles describe the system's complete history. A hierarchy exists between them: local processes construct global evolution, while global evolution alters the way local processes unfold.

An organism breathes countless times, renews its cells, and undergoes metabolic and hormonal cycles, but all these cycles are integrated into the long cycle of its life. A star undergoes pulsations, instabilities, energy exchanges, and internal transformations, but all are integrated into its evolutionary cycle, from formation until it ceases to exist as a star in its initial form. A river undergoes seasonal variations, floods, and droughts, but all are integrated into the geomorphological history of its basin.

This structure shows that chronological time is insufficient for a complete description of evolution. Two systems may exist for the same length of time but undergo different numbers of adaptations. Two organisms may be the same age but have very different biological states. Two rivers may have existed for the same period, but one may have shifted its bed countless times while the other has barely changed. Two stars may be similar in age but occupy distinct evolutionary phases.

The difference is determined not only by time, but by the number, intensity, and accumulation of the processes undergone. A system's state is not merely its position in a temporal sequence, but its position within a history of adaptations. Here the need emerges to introduce the concept of cycle as an evolutionary variable.

The cycle must not be reduced to perfect periodicity. In natural systems, a cycle is most often repetition with difference. It contains return, but also accumulation. It contains conservation, but also transformation. For this reason, the cycle can describe what time alone does not adequately express: the internal structure of evolution.

When geometric adaptation can no longer preserve function, the system's existential cycle approaches its limit. The disappearance of the system does not mean the absolute disappearance of matter, energy, or information, but the loss of a form of coherence. What belonged to the system is redistributed, reconfigured, and integrated into other processes. Thus, the end of one system becomes the possible beginning of others.

From this perspective, emergence, evolution, and disappearance are not separate events, but phases of the same natural cycle. The system emerges when flows can be organized into a new coherence, evolves through successive adaptations, and disappears when adaptation can no longer preserve function. This scheme prepares the extension of the classical space–time framework by introducing a third conceptual variable: the cycle.

[D] Criterion for the limits of adaptation

Every coherent system has a finite capacity for geometric adaptation. When its fundamental function can no longer be preserved through reorganization, the system loses its initial coherence, and the matter, energy, and information it contained are integrated into new evolutionary processes.

2.8. Space–time–cycle: a new perspective on the evolution of natural systems

The modern description of the Universe has been built, in different forms, on the relationship between space and time. Classical mechanics treated space and time as distinct backgrounds for motion. Relativity united them into a space–time structure in which geometry is inseparable from gravity. Quantum mechanics, although it radically changes the interpretation of reality, still operates with states, evolutions, and probabilities defined in relation to space and time.

This framework has produced some of science's greatest achievements. Yet when natural systems are analyzed as processes of adaptation, a conceptual limitation becomes visible. Space describes distribution and geometry. Time describes sequence and duration. But neither space nor time directly expresses a system's position in its own evolutionary history.

A system is defined not only by where it is and the moment at which it is observed. It is also defined by what it has undergone. Two systems may be observed simultaneously and may have comparable lifetimes, yet occupy completely different evolutionary states. This difference cannot always be reduced to spatial coordinates or chronological age.

In biology, the same age can conceal different stresses, metabolic cycles, traumas, and adaptations; in ecology, the same interval can lead one ecosystem toward expansion and another toward degradation. These cases complement the geomorphological and stellar examples above: a common duration does not imply the same internal history.

These examples show that evolution is not merely duration. Evolution is an accumulation of transformations. Time measures sequence, but does not encode the internal structure of that sequence. To describe this structure, a concept is needed that expresses the cycles of adaptation through which the system constructs its state.

In the Unified Theory, this concept is called the cycle. The cycle is the evolutionary variable that describes a system's position in its own history of organization, adaptation, and transformation. It does not replace time or contradict space–time; rather, it completes the description when the system's state depends on the succession of repetitive processes that have shaped it.

Space describes the system's geometry. Time describes the dynamics of that geometry's transformation. The cycle describes how far the system has progressed through its own evolutionary process. Together, these three concepts permit a complete description of natural systems, especially those maintained through continuous adaptation.

The cycle must be understood hierarchically. There are short, local cycles that maintain immediate functions: pulsations, oscillations, rotations, breaths, metabolic exchanges, variations in flow rate, and periodic instabilities. There are also long, global cycles that describe the system's entire existence: emergence, maturation, transformation, degradation, and disappearance. Short cycles build the long cycle, and the long cycle gives meaning to the accumulation produced by short cycles.

This interpretation differs from the idea of perfect repetition. In nature, a cycle never recreates exactly the same state in the same space and at the same time. Each return occurs in a system already altered by the preceding return. The natural cycle is therefore closer to an evolutionary spiral than to a closed circle. It contains recurrence, but also direction. It contains repetition, but also the arrow of time.

By introducing the cycle, evolution can be understood as a succession of repetitive and cumulative transformations. A system does not merely move through time; it passes through phases. It does not merely endure; it is consumed, reorganizes itself, preserves its function, exhausts its possibilities, and becomes integrated into other processes. The cycle expresses this internal dimension of evolution between a beginning and an end.

This new perspective has fundamental consequences for systems theory. If a system's state depends on the cycles it has undergone, then its complete description must include not only its instantaneous geometry and chronological time, but also the history of its adaptations. In other words, a system is defined through space, time, and cycle.

The Universe can thus be viewed not as a collection of objects set within a space–time backdrop, but as a network of systems engaged in permanent cycles of organization, transport, adaptation, and transformation. Every system has a geometry, a dynamics, and a position within its own evolutionary cycle. Every system receives, organizes, and transmits onward what traverses it.

In the following chapters, this perspective will be applied to coherent helical flows. There, the relationship among system, transport, geometry, adaptation, and cycle becomes particularly clear. Vortex tubes will be analyzed as geometrodynamic structures capable of organizing transport in a coherent, adaptable, and evolutionary form. They appear not as mere accidents of fluids, but as privileged forms through which nature can achieve organized transport on the basis of the differences that set systems in motion.

[H] Space–time–cycle proposition

A complete description of an evolving natural system necessarily requires three complementary and fundamental perspectives: space, which describes geometry; time, which describes the succession of transformations; and the cycle, which describes the system's position in its own history of adaptation, accumulation, and transformation.

2.9. Geometrodynamic time — the measure of the system's geometric transformation

In established physics, time orders events and allows durations to be measured; in relativity, it is inseparable from space, motion, and gravity. The Unified Theory does not replace these meanings. It introduces geometrodynamic time, T_{gd} , as an internal process variable intended to describe the transformation of the geometry of a delimited system.

T_{gd} measures the succession of configurations through which the system passes as it adapts, organizes itself, or loses coherence. It does not answer the question “how much time has elapsed?” but “how much relevant transformation has the system undergone?” External duration and internal evolution thus remain distinct quantities.

Operationally, a protocol must be selected: observable geometric variables, resolution, observation interval, and the threshold beyond which a change is considered a reconfiguration. For a geometry with no reorganization detectable under the selected protocol, one may write $T_{gd}=0$. This notation does not mean that physical or proper time has stopped, but that no internal evolution is resolvable by the declared measurement.

Two systems of the same chronological age may have different geometrodynamical histories. A river that has repeatedly shifted its bed has accumulated more geometric transformation than an almost stable river, even if both are equally old. The relevant difference is the number, amplitude, and irreversibility of the reconfigurations, not merely the duration.

Geometrodynamical time and the cycle are not synonymous. T_{gd} expresses accumulated transformation, whereas the cycle indicates the system's internal position among genesis, stabilization, adaptation, limit, and reconfiguration. Short cycles may produce the accumulation measured by T_{gd} , while the long cycle integrates these transformations into the system's complete history.

To become a quantitative quantity, T_{gd} must subsequently be linked to a state metric: the variation of a geometry, the distance between two configurations, or the normalized number of relevant transitions. Until such a metric is defined, it has the status of a working variable that separates the observer's duration from the system's internal transformation.

[D] Working definition of geometrodynamical time

The geometrodynamical time of a system expresses the successive transformation of its geometric configurations, measured through an explicit protocol. For a geometry with no detectable reorganization, one writes $T_{gd}=0$, without implying that time, as an arbitrary reference external to the system, has stopped.

This distinction prepares the introduction of geometrodynamical mass: if T_{gd} describes how much the internal architecture changes, M_{gd} will describe which mass participates functionally in the process that produces the transformation.

2.10. Geometrodynamical mass — matter captured within the systemic process

Geometrodynamical mass, M_{gd} , denotes the mass that participates functionally in the internal process of a delimited system. It does not propose a new type of mass and does not replace inertial, gravitational, or mass–energy concepts. From the mass present in a domain, the concept selects the portion temporarily captured within the system's architecture of transport, transformation, and adaptation.

[D] The definition requires a functional domain Ω_f and a membership criterion. Matter becomes part of M_{gd} when it passes through IN, is retained or reorganized within Ω_f , and contributes to the function being tracked. When it is discharged through OUT or no longer participates in the process, it ceases to belong to the geometrodynamical mass of that system, even if it remains nearby.

Therefore, M_{gd} is not simply the total mass within a control volume. Two volumes may contain the same mass, yet only a fraction may be entrained in the selected functional process. The difference is established by measuring flows, residence time, density distribution, and the material's effective role in transport; it cannot be inferred from the mere presence of matter.

The minimal architecture is: external matter $\rightarrow$ loading through IN $\rightarrow$ mass temporarily integrated into $\Omega_f \rightarrow$ internal transformation $\rightarrow$ discharge through OUT. In an open balance, M_{gd} may increase, decrease, or remain approximately constant, depending on the difference between inputs, outputs, and any internal sources or losses defined by the model.

The examples are functional, not statements of identity. In an organism, ingested matter is temporarily integrated into metabolism and tissues; in a river, water and sediment participate in transport and in reshaping the bed; in a star, captured matter participates in gravitational and energetic processes. On a conveyor belt, the luggage actually on the belt provides the simplest technical analogy: it belongs to the process only while it is received, moved, and discharged by the system.

M_{gd} and geometry condition one another. A greater load may require enlarged cross-sections, redistributed paths, or a change in the flow regime; the available geometry, in turn, limits the mass that

can be maintained coherently. Instability arises when the functional load exceeds the system's capacity for reorganization or when the flow becomes insufficient to maintain the function.

In relation to T_{gd} , M_{gd} represents the material substrate of the transformation being analyzed. T_{gd} describes the evolution of configurations, while M_{gd} describes the mass involved in that evolution. The relationship between them must not be assumed to be universal, but formulated through the balance and observables of each system.

The character of M_{gd} is local, temporary, and scale-dependent. What is OUT for one system may become IN for another, and the same matter may belong successively to several processes. The attractor, introduced later, will denote the region of potential difference that favors the capture and organization of this mass.

[D] Working definition of geometrodynamical mass

The geometrodynamical mass of a system is the mass temporarily integrated into its functional domain and participating in transport, transformation, and geometric adaptation. It is determined through an explicit membership criterion and an IN–OUT balance, not merely by the mass present within the volume.

2.11. The geometrodynamical system — synthesis of the conceptual framework

A geometrodynamical system is a delimited, open, and functional domain in which flows connect the IN and OUT regions through a geometry capable of adaptation. Its identity does not depend on preserving the same matter or the same form, but on the continuity of the relationships that maintain its function during transformation.

The conceptual architecture can be followed without repeating the definitions: delimitation establishes interior and exterior; IN introduces the relevant mass or energy; M_{gd} identifies the participating mass within the functional domain; T_{gd} measures the transformation of geometry over time; the cycle locates the internal stage; and OUT transfers the result to the environment or to another system.

These notions have different statuses. Delimitation, balance, and transport are general analytical tools; T_{gd} , M_{gd} , and the cycle are original definitions that require measurement protocols; extending them to helical flows, particles, or cosmology remains a hypothesis. The next chapter establishes the method by which an intuitive pattern can be transformed into a testable hypothesis.

3. From intuitive pattern to testable hypothesis

3.1. Pattern before theory — intuitive recognition of natural order

Before formulating equations, cognition recognizes forms: alternations, flows, rotations, branchings, symmetries, and cycles. This recognition is not yet an explanation, but it makes the scientific question possible. A pattern is the first indication that a process produces enough order to be compared with other processes.

The recurrence of a spiral, a tree, or a vortex does not, however, demonstrate the existence of the same mechanism. A shell, a galaxy, and an atmospheric vortex belong to different materials, scales, and local laws. Visual similarity may suggest a line of inquiry; by itself, it cannot constitute evidence of physical unity.

The first volume traced the intuitive and cultural extension of these patterns. Volume II changes their status: the image becomes a structural hypothesis. The question is no longer “where does the form appear?” but “what system produces it, what function does it perform, what relationships does it conserve, and under what conditions does it disappear?”

The transition from pattern to analysis requires four operations: delimiting the system's form within a spatial domain, identifying its function, reducing it to the minimal mechanism, and comparing it with already validated explanations. If the form cannot be linked to observations and falsification conditions, it remains an analogy. If the functional relationships withstand measurement in the declared domain, the pattern becomes a theoretical candidate.

Intuition retains its creative role, but not the final verdict. It can quickly perceive convergences that local analysis misses; method slowly decides whether those convergences are real. The clarity of an image opens the inquiry, and measurement establishes its limits.

Methodological observation of the pattern

A natural pattern becomes scientifically relevant only when it can be delimited, described functionally, and confronted with a comparative model. Visual recurrence generates the hypothesis; measurable relationships and differential tests decide whether a common mechanism exists.

3.2. The system in science — from isolated object to open ensemble

Modern science began with idealized objects: bodies, masses, trajectories, and forces. This simplification made precise measurement possible, but the isolation of the body remained a methodological approximation. As the phenomena under analysis became more complex, description had to include the domain, the boundary, and exchanges with the exterior.

Thermodynamics introduced systems and balances; fluid mechanics, control volumes and boundary conditions; electromagnetism, distributed fields; biology and ecology, networks of exchange and regulation. In each case, the isolated object was retained as a local approximation but integrated into a broader dynamic ensemble.

The Unified Theory adopts this shift without declaring the object useless. The object remains what the observer can localize and measure; the system also includes the processes that produce, maintain, and transform it. A stable form can thus be treated as a local manifestation of a broader organization.

Consequence of the transition from object to system

The object is a useful local idealization, while the system is the complete unit of analysis: domain, boundary, exchanges, internal processes, and conditions of persistence. This extension leads directly to the question of whether substance or process is the primary explanatory level.

3.3. From substance to process — the fundamental question: what is primary?

Direct experience presents the world as a collection of things, with motion appearing to be a subsequent property of them. Analysis of active systems, however, reverses the order of the question: an organism, a river, or a vortex preserves its identity even though the matter traversing it changes continuously. What persists is the organization of the process, not the same substance.

An organism is maintained through metabolism, regulation, and regeneration. A river remains recognizable through the continuity of its flow, even as the water, sediments, and bed change. A vortex exists only while the fluid sustains a coherent region of rotation and transport. In all these cases, the visible object is a temporary stabilization of a dynamics.

Modern science has already weakened the image of rigid substance through fields, states, excitations, symmetries, and dynamic geometries. This does not automatically demonstrate the ontology proposed here, but it shows that physical identity can be linked to relationships and invariants, not only to an unchanging material substrate.

The Unified Theory adopts process as the primary explanatory level: a difference of state produces transport, transport organizes geometry, and coherent geometry makes the emergence of an observable object possible. Objects are not denied; they are treated as local manifestations of the processes that produce and maintain them.

This choice redefines stability. A system is stable not because it remains unchanged, but because it preserves essential relationships during change. Identity becomes functional continuity, and geometry becomes the adaptive solution through which the process preserves its coherence.

This choice has a precise methodological consequence. If process is primary, the theory must begin with flow, transport, boundaries, invariants, and transformations, and then show how observable forms result. The volume's central candidate is coherent helical flow, analyzed later as a vortex tube.

[H] *Process-priority hypothesis*

In active natural systems, the observable object may be modeled as the temporary stabilization of a deeper process. The hypothesis is valid only if the proposed process recovers the object's measured properties and produces predictions that differ from those of the standard description.

3.4. The common-pattern method — from intuition to testable hypothesis

A theory constructed from patterns risks confusing resemblance with law. The common-pattern method avoids this confusion through an explicit sequence of checks. The observed form is the starting point; the mechanism, comparator, and prediction determine whether it has theoretical value.

Stage 1 — observing recurrence. The repeated form or sequence is identified and described without ontological conclusions. Intuition may select the phenomenon, but it does not establish its cause.

Stage 2 — delimiting the system. The interior, exterior, boundary, scale, and observation interval are specified. Without this delimitation, one cannot decide what belongs to the phenomenon and what belongs to the environment.

Stage 3 — identifying the function. The form is asked what it accomplishes: does it distribute, collect, rotate, stabilize, filter, transmit, or discharge? Function transforms geometry from an image into an object of physical analysis.

Stage 4 — reduction to the minimal mechanism. The necessary variables are retained from the phenomenon's complexity: gradient, flow, direction, boundary, geometry, state, and transformation. The reduction is acceptable only if it does not eliminate the very effect that must be explained.

Stage 5 — comparison and verification. The scheme is confronted with the best established model and tested against data or systems not used in its formulation. Occurrence in different domains is not sufficient; the proposed relationship must add explanatory or predictive power.

Stage 6 — domain and falsification. The domain in which the hypothesis should operate, the effect size, the uncertainty, and the result that would constrain or reject it are declared. An idea that explains every result after it occurs cannot be tested.

Clarity has a practical role here. A mechanism must be formulated simply enough for its consequences to be traced, without hiding unknowns in language. A clear explanation is not automatically true, but it can be tested; an ambiguous one evades the very risk that can transform it into science.

Applied to the vortex tube, the method requires more than recurrence of form. It must be shown that the system has a boundary, axis, transport, rotation, state variables, invariants, adaptation mechanisms, and conditions under which coherence is lost. If these requirements cannot be measured, the vortex remains a metaphor; if they can be measured and compared, it becomes a technical hypothesis.

[F] Criterion for verifying the common pattern

A recurring pattern becomes a theoretical candidate only if it is transformed into a delimitable functional scheme, compared with standard explanations, and exposed to a result capable of refuting it. Analogy initiates the inquiry; invariants and prediction determine its value.

3.5. Vortex theories — the first historical thread toward a physics of flow

Before modern physics arrived at quantum fields, curved space–time, and elementary particles, one of the most natural images of the world was that of flow. For many thinkers, nature seemed closer to a medium in motion than to a collection of solid objects suspended in empty space. The vortex thus emerged as one of the earliest forms through which motion could be conceived as organization.

This intuition was not accidental. A vortex has a feature that distinguishes it from simple linear displacement. It is not merely motion, but motion organized around an axis. It has rotation, coherence, relative persistence, a dynamic boundary, and the capacity to concentrate or redistribute matter and energy. ***For this reason, the vortex was one of the earliest dynamic geometries through which people sought to understand the hidden order of the world.***

In René Descartes's natural philosophy, the Universe was imagined as a plenum: a medium with no true vacuum, filled with subtle matter in motion. Celestial bodies did not move through empty space, but were carried by cosmic vortices. This vision does not correspond to current physics, but it has major historical importance: it shifted attention from isolated bodies to organized motions within a continuous medium. Space was not inert, and motion was not merely a property of an object; motion belonged to the medium itself.

The Cartesian vortex theory was abandoned as an astronomical explanation, especially after the success of Newtonian mechanics. Yet it preserved a question that would periodically reappear: can the structure of the world be derived from organized motions of a continuous substrate? Although Descartes's answer did not endure, the question remained alive.

A far more rigorous step was taken in the nineteenth century with the mathematical study of vortices. Hermann von Helmholtz formulated the fundamental theorems of vorticity in ideal fluids, showing that vortex lines and tubes can possess properties of conservation and persistence. For the first time, the vortex was no longer merely an intuitive image, but an object of mathematical analysis. It could be tracked, described, and treated as a coherent structure in a continuous medium. [4]

This stage is decisive. A vortex line is not a material object in the ordinary sense, yet it can have a dynamic identity. A vortex tube is not a solid tube, yet it can preserve a form of organization. Fluid physics thus introduced a profound idea: a structure can exist as the persistence of motion, not as the solidity of substance. Identity can be dynamic.

On this basis, Lord Kelvin formulated the vortex-atom theory. In this theory, atoms were not indivisible solid particles, but stable vortices in a continuous medium. Differences among the elements were to be explained by different forms of knotting, linking, or organization of these vortices. From this perspective, matter became a consequence of the topology of flow. [5]

The vortex-atom theory did not survive as a model of matter. The discovery of the electron, the development of quantum mechanics, and the emergence of particle physics took physics in another direction. Yet the model's historical failure does not erase its conceptual importance. Kelvin formulated one of the boldest ideas in nineteenth-century physics: a particle could be a stable structure of flow.

In an early form, this idea contained three elements that would reappear in modern physics. The first is stability through configuration rather than rigid material. The second is the role of topology in preserving identity. The third is the possibility that observable objects are effects of a deeper dynamics. Although Kelvin's theory was tied to the ether hypothesis, the structural intuition it contained outgrew its historical framework.

Peter Guthrie Tait developed the connection between vortices and knot theory, attempting to classify the possible knotted structures of vortex atoms. This attempt gave rise to an important mathematical field. Even after the original physical motivation disappeared, knot theory continued to develop and later became relevant in very different domains, from topology to molecular biology and condensed-matter physics.

This development is instructive. A physical theory may sometimes be wrong in its concrete form yet fertile in the principles it opens. The vortex-atom theory did not explain the atom, but it showed that stability, identity, and differentiation could be conceived geometrically and topologically. It showed that matter could be viewed not only as substance, but as organization.

Maxwell, in turn, used mechanical models based on molecular vortices to visualize the behavior of the electromagnetic medium. His mechanical model is not modern electromagnetic physics, but it played a heuristic role. It helped construct an image through which the relationship among electricity, magnetism, and wave propagation could become intelligible. Once again, the vortex appeared as an intermediate form connecting motion, stress, rotation, and transmission. [1]

The importance of these attempts does not lie in literally retaining the ether or old mechanical models. The present work explores the hypothesis of a continuous dynamic substrate without claiming that current physics must reintroduce the classical ether. Such a substrate would become physically acceptable only if it respected Lorentz invariance and produced testable differential predictions. The historical value of the old models is that they kept open a description in terms of circulations, stresses, rotations, continuities, and invariants.

When these models were abandoned, physics gained mathematical rigor but partially lost the direct mechanical image of the substrate. Fields became highly precise yet increasingly abstract formal entities. Particles became quantum objects described by states, operators, and symmetries. Space-time became geometry. In this process, the vortex remained primarily within fluid mechanics, plasma physics, condensates, superconductors, superfluids, and other specific domains.

Yet the idea did not disappear. It returned in more refined forms: quantum vortices, magnetic-flux lines, topological defects, solitons, skyrmions, knots in physical fields, coherent structures in turbulence, and tubes of vorticity in fluids. In these modern theories, the vortex is no longer merely an old cosmic image, but a real, measurable physical structure capable of organizing energy, momentum, geometric information, and stability.

This historical continuity is important to the present work. The Unified Theory does not invent from nothing the idea that the vortex may have a fundamental role. It stands within a long line of questions, intuitions, and models. The difference lies not in the simple use of the vortex, but in the way it is

integrated into a more general framework: open system, coherent transport, geometric adaptation, evolutionary cycle, and kinematic identity.

Historical vortex theories emphasized form and topology. In the present theory, the emphasis shifts toward the kinematic state of flow. A vortex is important not only because it has a certain form, but because it can conserve a set of dynamic relationships while its geometry adapts. Form may vary, yet the identity of the flow can persist if its invariants remain conserved.

This shift changes the meaning of the problem. The question is no longer merely whether particles are vortices in the sense of Kelvin's old theory. The question becomes more general: can stable natural structures be understood as coherent regions of flow, defined by kinematic invariants and by their capacity to adapt their geometry? If the answer is affirmative, the vortex is no longer an isolated model of the atom, but a prototype of a geometrodynamics system.

From this perspective, the vortex tube becomes more important than the simple image of the vortex. A vortex tube has continuity, cross-section, axis, flux, circulation, a dynamic boundary, and the capacity to transport structure in a direction. It unites local rotation with axial displacement, precisely the form of motion that will become central to helical analysis.

Historical vortex theories should therefore be viewed as a first approximation to a deeper idea. They intuited that organized motion could produce identity. They intuited that topology could preserve stability. They intuited that matter might be dynamic form rather than inert substance. They lacked, however, the framework needed to connect this intuition to systems theory, transport, evolutionary cycles, and global kinematic invariants.

The Unified Theory takes up this thread but moves it to another stage. It is not enough to say that the atom is a vortex. One must define the vortex-system, the flow that feeds it, the geometry that stabilizes it, the invariants that preserve its identity, the conditions that permit adaptation, and the limits that produce decoherence. Only then can the vortex move from the realm of historical imagery into that of a fundamental theoretical object.

Thus, the history of vortex theories is not a mere curiosity. It represents the first major thread through which science attempted to conceive reality as organized motion. Although these theories have been superseded, they preserved an open question: what if the stable forms of matter are not the ultimate elements of reality, but expressions of a deeper flow?

[R] Proposition on the continuity of vortex theories

Historical vortex theories showed that a physical structure can be conceived as the persistence of organized motion, not only as a rigid material object. Although the classical models have been superseded, they introduced the fundamental idea that stability, identity, and differentiation can arise from flow, topology, and dynamic coherence.

3.6. Geometry becomes physics — from Einstein to Wheeler

If vortex theories attempted to understand matter through organized motion in a continuous medium, another major direction in physics followed a different path: understanding nature through geometry. In this direction, the question was no longer only what moves and through which medium, but which geometric structure makes motion itself possible.

For a long time, geometry was regarded as a language of description rather than physical reality. It provided methods for measuring distances, angles, surfaces, volumes, and trajectories. Space was the background through which bodies moved, and geometry was the instrument used to represent that background. In classical mechanics, objects moved within a space assumed to be fixed, while time flowed independently of the state of systems. Geometry was the framework, not the phenomenon.

This separation began to change with the development of non-Euclidean geometries. The existence of coherent geometries different from Euclidean geometry weakened the idea that space had to be conceived as a rigid and absolute setting. Riemann introduced the possibility that geometry could be characterized by intrinsic properties, curvature, and variable metric relations. At that point, geometry ceased to be merely the study of ideal forms and became a language capable of describing flexible, configuration-dependent structures.

Einstein's General Relativity transformed this mathematical possibility into a physical revolution. Gravity was no longer described as an ordinary force exerted between bodies, but as an effect of the geometry of space-time. Mass and energy influence geometry, and geometry influences motion. This

idea profoundly changed the status of geometry: space and time were no longer passive backgrounds, but active components of the gravitational phenomenon. [39]

The importance of this change cannot be overstated. For the first time, a fundamental interaction was expressed as a geometric property. Gravity was no longer added onto space, but was inseparable from its structure. The trajectory of a body was no longer merely the result of a force, but the expression of how the body follows the geometry of space-time. The global form of reality thus became part of physical law.

This transition inaugurated a new direction of thought: if gravity can be geometrized, perhaps other properties of matter can also be understood geometrically. This was not merely a mathematical ambition, but an attempt to reduce the diversity of phenomena to deeper structures. Geometry appeared to offer a unifying language capable of connecting motion, fields, and the structure of the Universe.

Yet the geometrization of gravity also produced a new problem. General Relativity describes large-scale geometry extremely well, but the microscopic world is described by quantum mechanics, which has a very different conceptual apparatus. On one side lies continuous, smooth, curved space-time. On the other lie quantum states, operators, probabilities, and discontinuities. Thus, the success of geometry in gravitation simultaneously raised the question of whether geometry can descend to the fundamental level of matter.

John Archibald Wheeler took this question to an exceptionally bold form. Through the concept of geometrodynamics, he proposed that the dynamics of geometry be regarded not merely as the background of matter, but as a possible source of matter. In this view, space-time was not a mere container, but an active structure capable of deformations, oscillations, closures, and configurations with physical properties of their own. Matter could be conceived, at least as a conceptual possibility, as a form of geometric organization. [40]

This idea represents a decisive step in the history of physical thought. If vortex theories suggested that objects could be stable forms of flow, geometrodynamics suggested that objects could be stable forms of geometry. In both cases, matter ceased to be regarded as a rigid primary substance. It became the result of a deeper structure: organized flow in one case and organized geometry in the other.

Wheeler also introduced an important intuition: fundamental reality might be far more active, fluctuating, and structured than the image of empty space suggests. At very small scales, geometry itself might become unstable, discontinuous, or foamlike. Although these ideas remained difficult to transform into a complete theory, they changed the fundamental question. It was no longer enough to ask which particles exist in space; one also had to ask whether space itself possesses structure, dynamics, and a capacity for organization. [40]

This direction influenced many subsequent attempts at unification. Quantum gravity, topological field theories, loop-based models, discrete geometries, theories with additional dimensions, and other modern programs have retained, in one form or another, the question opened by Einstein and Wheeler: can geometry be the foundation of physical reality?

The answers have differed, but the general direction is clear. Modern physics no longer treats geometry as a mere drawing of reality. Geometry has become the language of gravitation, fields, symmetries, topology, state spaces, and fundamental theories. In many domains, understanding a phenomenon means understanding the geometric structure that organizes it.

Yet an important limit appears here. However sophisticated, a geometry describes structural relationships. It can state how points are connected, how distances are measured, how curvature arises, how trajectories behave, and how certain symmetries are conserved. But geometry alone does not always explain why that structure emerges, what feeds it, what stabilizes it, and which process compels it to transform. Geometry can become physics, yet the question remains whether it is the ultimate level of reality or the expression of a deeper process. This is a fundamental question.

This is the essential difference between traditional geometrodynamics and the direction proposed in the present work. In geometrodynamics inspired by Wheeler, geometry tends to become the primary element. In the Unified Theory, geometry is essential, but it is not the final term. It is the visible response of an adapting coherent flow.

In other words, geometry is not denied, but repositioned. It is no longer treated as an inert foundation, but as a dynamic form produced by process. Curvature, twisting, axialization (*elongation*), branching, or self-closure (*toroidal*) are not merely properties of an abstract space, but ways in which a flow organizes its existence. Geometry becomes the imprint of the conservation process.

This repositioning is important because it unites the two historical directions discussed thus far. From vortex theories it retains the idea that organized motion can produce identity. From geometrodynamics it retains the idea that geometric form has physical reality. The Unified Theory places them in a hierarchical relationship: organized flow produces geometry, and the resulting geometry stabilizes the flow.

Through this relationship, geometry and dynamics are no longer separate domains. Geometry is not the static drawing of a process, and dynamics is not merely the change of a form. They become two aspects of the same mechanism: flow alters its geometry to preserve its coherence, and the altered geometry changes how the flow can continue.

This formulation prepares the central concept of the work: helical geometrodynamics. The term denotes not merely a geometry that moves, but a flow that produces adaptive geometry. The flow helicoid is not added as an ornament of form, but emerges as a possible solution through which rotation and axial displacement combine in a coherent transport structure.

From this standpoint, Einstein and Wheeler mark an indispensable but not final stage. Einstein showed that geometry can become gravitation. Wheeler suggested that geometry can become matter. The Unified Theory proposes a further reversal: coherent flow can become geometry, and geometry can become the form through which matter is observed.

This reversal does not diminish the importance of geometry, but makes it more physical. A geometry that emerges from flow is not an abstraction imposed on reality, but the result of an internal necessity of the process. It has a functional role because it permits the conservation, adaptation, and transmission of structure. *Thus, geometry ceases to be merely a framework or form and becomes a mechanism of continuity.*

From this perspective, space, time, and cycle cannot be separated from the process that makes them observable. Space is expressed through the local geometry of flow. Time expresses the transformation of geometry. The cycle expresses the internal history of adaptations. Physical geometry is no longer merely the stage on which processes unfold, but the form through which processes become persistent and recognizable.

The transition from Einstein to Wheeler is therefore not merely a historical episode. It demonstrates the maturation of an idea: the world cannot be fully understood without geometry. But the next step is to ask what produces geometry. For the Unified Theory, the answer is not a deeper geometry, but a deeper flow capable of organizing itself, preserving itself, and adapting its form.

[H] Proposition of emergent geometry

Geometry is not merely the framework delimited within a domain (space) in which phenomena unfold, but the physical expression of an organizing process. In the Unified Theory, geometry becomes real through the flow that produces it, modifies it, and uses it to preserve the coherence of the system.

3.7. Topology, knots, and solitons — stability without a rigid object

One of the most important advances in modern physics was the recognition that stability need not arise from the rigidity of an object. A structure may persist not because it is hard, compact, or materially fixed, but because it has a configuration that is difficult to undo. At this point, physics leaves the simple image of the solid object and enters a deeper domain: stability through relationship, linkage, continuity, and topology.

Topology studies properties that remain unchanged when a form is continuously deformed without cutting or gluing. This idea is important to physics because many natural structures are stable not through their exact geometry, but through how they are connected. Form may change, but linkage may remain. A contour may deform, but the knot may persist. Local geometry may vary, while the global structure preserves an identity.

A knot provides a simple image of this difference. A cord may be stretched, curved, twisted, or compressed, but if the knot is not cut or undone through an allowed transformation, it preserves its identity. What is essential is neither the knot's exact size nor its instantaneous form, but the way the strand is linked with itself. Stability no longer belongs to the exact geometric form, but to the topological class.

This idea gradually entered many domains of physics. In fluids, vortices can form knotted or linked structures. In plasma, magnetic field lines can be twisted and braided. In condensed matter, topological defects may arise that do not easily disappear because eliminating them would require a global

reorganization of the system. In quantum fields and magnetic materials, certain excitations can be stabilized by topological properties. Topology thus becomes a way of understanding persistence.

Solitons represent another important step in this direction. In nonlinear regimes that admit such solutions, a soliton can travel with limited dispersion because nonlinearity offsets the tendency to spread. It is not a solid object, but it can remain recognizable and exhibit nearly elastic interactions in certain systems, especially integrable ones. Persistence or recovery after perturbations is not universal, but depends on the equation, stability, and environmental conditions.

This observation is essential. A soliton shows that a form can be carried by a process. There is no object separate from the medium that supports it. There is a stable organization of a field or a flow capable of preserving a particular identity during propagation. In such a case, the boundary between object and process becomes unclear. What appears to be an object is in fact a persistent form of evolution.

Skyrmions and hopfions take this idea further. They are localized topological textures introduced in field models and subsequently observed in physical systems, including magnetic materials. Their stability depends on topology, energy, interactions, and boundary conditions; the existence of these textures is a physical precedent, not confirmation of the Unified Theory proposed here. [12,13,38]

Through such examples, modern physics began to accept an idea that would have been difficult for classical theories of the object: observable entities can be stable configurations of a medium, field, or flow. They may have identity not because they are indivisible pieces of substance, but because the system cannot easily transform them into something else without overcoming a structural barrier.

Topological defects confirm the same logic. In crystals, materials, ordered fluids, condensates, or fields, regions can arise in which the local order is interrupted or twisted. These defects are not mere imperfections. They can carry structural information, control transitions, influence the system's global properties, and persist because of the way they are integrated into the overall configuration.

Through these developments, physics discovered a new type of object: the configurational object. It is defined primarily not by its material, but by its organization. It is stable not because it is compact, but because it is topologically constrained. It is individualized not by a solid boundary, but by a specific mode of linking, twisting, winding, or continuity.

This transformation is of major importance to any theory seeking to understand nature at a fundamental level. If stability can be produced through topology, then particles, vortices, fields, or biological structures can be viewed differently. *Their identity no longer needs to be sought only in composition, but in the configuration that permits persistence. Matter becomes less a "thing" and more an "organization."*

Yet topology does not exhaust the problem. It explains why a structure may remain stable under certain deformations, but not always why that structure emerges, which flow maintains it, which transport regime supports it, or what makes it compatible or incompatible with other structures. Topology describes the continuity of the configuration, but it is not, by itself, a complete description of the dynamics that produces the configuration.

This limitation is important. Two structures may belong to the same topological class yet behave differently in physical terms. They may have the same type of linkage but different energies, velocities, transport regimes, stabilities, or modes of interaction. Topology says what does not change under continuous deformation, but it does not fully describe how the system flows.

For the present work, topology is therefore a necessary but not final stage. It shows that identity may be deeper than instantaneous geometry. It shows that structure can survive deformation. It shows that the exact form may vary while a certain type of organization remains. But to reach helical geometrodynamics, an additional level must be added: the kinematic state.

The kinematic state describes not only how the structure is linked, but how it maintains itself through flow. It includes direction, rotation, transport, adaptation, rhythm, coupling, and invariants. A structure is defined not only by being knotted, twisted, or closed, but by the way this configuration participates in a coherent process. In this sense, topology provides the skeleton of stability, while kinematics provides the structure's dynamic life.

This distinction prepares one of the central ideas of the Unified Theory: two structures may be geometrically or topologically similar yet kinematically incompatible. Conversely, two structures may have different geometries and still belong to the same family if they preserve the same fundamental kinematic relationships. Identity is therefore determined neither by form alone nor by topology alone, but by the invariants conserved during flow and adaptation.

This is where the fundamental constants (*Preda*) enter. They must not be understood as mere labels of form, but as quantities of geometrodynamic *identity*. *While topology describes the type of linkage a structure has, the kinematic constants describe the type of flow that structure is. This distinction permits the transition from the passive stability of configuration to the active stability of process.*

A knotted vortex may be topologically stable, but the question posed by the present theory goes deeper: which flow parameters preserve its identity? Which ratios must be conserved for the structure to remain coherent? How does geometry change when the environment changes? When does adaptation preserve identity, and when does it lose it? These questions belong not only to topology, but to geometrodynamics.

Topology, knots, solitons, and skyrmions are therefore introduced here not as final explanations of nature, but as historical and conceptual evidence that physics has already moved beyond the model of the rigid object. They show that structure can be processual, configurational, and protected by internal relationships. They prepare the ground for a theory in which matter is understood as a coherent organization of flow.

For the Unified Theory, the next step is clear. If topology shows that form can preserve identity through linkage, helical geometrodynamics must show how flow preserves identity through kinematic invariants. Stability will no longer be attributed only to the knot, but to the entire flow regime that produces, maintains, and adapts the knot.

From this perspective, the natural world is no longer composed of rigid objects that happen to interact, but of coherent structures maintained through self-organization. Some are topologically protected, others energetically stabilized, and still others sustained by transport; the most interesting combine all these levels. The helical vortex tube will be analyzed precisely as such a structure: not merely form, not merely topology, but a coherent process with kinematic identity.

[H] Proposition of configurational stability

A natural structure can be stable without being materially rigid. Stability can arise from linkage, continuity, topology, and dynamic organization. In the Unified Theory, this stability becomes complete only when the configuration is supported by a coherent kinematic state and by the invariants of flow.

3.8. The limits of current theories — local precision and a foundational divide

Modern physics is one of humanity's most powerful intellectual constructions. It has produced predictions of extraordinary precision, technologies unimaginable in earlier eras, and models capable of describing phenomena from the subatomic to the cosmological scale. For this reason, any attempt at fundamental reformulation must begin with a clear acknowledgment: current theories are not vulnerable because of their results, but because they lack a common level of interpretation.

The problem is not that current physics does not work. The problem is that it works through different frameworks, each remarkable in its own domain but difficult to bring to the same foundation. General Relativity describes gravity through the continuous geometry of space–time. Quantum Mechanics describes the microscopic world through states, operators, probabilities, and amplitudes. Quantum Field Theory describes particles as excitations of fields. Thermodynamics describes statistical transformations and energy balances. Information theories describe the transmission and encoding of states. Each language is effective, but none alone becomes a common language for all the others.

This situation produces conceptual fragmentation. In one domain, fundamental reality appears to be the particle; in another, the field; in another, geometry; in another, information; in another, symmetry; and in yet another, probability. These descriptions can be correlated mathematically, but it is unclear whether they indicate the same type of physical reality or merely different modes of calculation applied to different phenomena.

General Relativity and Quantum Mechanics provide the best-known example of this divide. The former treats space–time as a dynamic structure. The latter, in most standard formulations, operates with quantum evolutions defined against an external time background or within a framework that is not itself quantized in the same way. In one, geometry is active; in the other, the quantum state is central. In one, continuity is natural; in the other, quantization is unavoidable. In one, gravity is geometry; in the other, interactions are treated through fields and quanta.

This is where the difficulty of unification arises. It is not merely a matter of combining two sets of equations. It is a matter of understanding what must be regarded as fundamental. If space–time is fundamental, quantum fields must be placed within it. If the quantum state is fundamental, space–time

must emerge from it. If information is fundamental, matter and geometry must be reconstructed informationally. If symmetry is fundamental, particles and interactions become its representations. Each choice completely changes the picture of the world.

Contemporary theories of unification attempt to resolve this difficulty through different strategies. Some quantize geometry. Others extend the number of dimensions. Some begin with deeper symmetries. Others use discrete structures, networks, loops, strings, branes, abstract state spaces, or informational principles. All these directions have research value. They show that physics has understood the depth of the problem. Yet their diversity also shows that there is still no agreement on the ontological level from which to begin.

This is the central limitation: current theories are formally powerful, but they do not yet offer a single picture of the physical substrate of reality. They describe behaviors, transitions, interactions, and experimental predictions extremely well, yet it remains difficult to say what exists at the fundamental level. Do particles exist? Fields? Geometry? Information? Only relationships? Or are all of these partial manifestations of a deeper process?

Physics has learned to calculate without always possessing a direct physical image of what it calculates. This is not a practical weakness, but a consequence of the mathematical refinement of its theories. Modern models can produce correct results even when their interpretation remains open. For a unifying theory, however, this situation is insufficient. Unification cannot be merely formal compatibility. It must also provide a common level of reality.

Another limitation arises from the separation of scales. At the microscopic scale, quantum behaviors dominate. At the macroscopic scale, objects, trajectories, classical fields, and continuous geometries emerge. At the cosmological scale, immense gravitational structures, expansion, distributions of matter, and phenomena still insufficiently explained come into play. Current physics uses bridges among these scales, but still lacks a complete description of how one level naturally produces another.

This problem is evident in the difficulty of explaining the transition from quantum to classical behavior. At the microscopic level, systems are described through superpositions, amplitudes, and probabilities. At the macroscopic level, we observe stable forms, localized objects, and apparently determined processes. Mechanisms such as decoherence exist between these two descriptions, but the question of the complete emergence of classical reality from the quantum substrate remains one of the major conceptual problems.

In cosmology, the limitations appear in another form. Dark matter and dark energy are introduced to explain differences between observations and existing models. They function within the current framework, but their nature remains unclear. This situation does not invalidate modern cosmology, but it indicates that the current description contains essential components that are still not physically understood. A theory with fundamental aspirations must be able to interpret such phenomena not merely as terms added to a model, but as natural effects of a deeper structure.

At the level of elementary particles, the Standard Model is extremely precise, but leaves important questions open. Why do exactly these families of particles exist? Why do they have these masses? Why these coupling constants? Why does matter dominate antimatter in the observable Universe? Why does gravity not integrate naturally into the same framework? These questions do not negate the model's success, but show that predictive success is not identical to a complete understanding of the foundation.

The limits of current theories must therefore not be formulated superficially. They are not limits of intelligence, rigor, or mathematical capacity. They are limits of a common perspective. *Physics has developed extremely powerful local theories, but has not yet established the single fundamental object or process from which these theories can be derived as particular regimes.*

This observation opens two paths. The first is the path of formal unification: attempting to construct a more general mathematical framework that includes existing theories. The second is the path of physical reduction: seeking a deeper physical process or structure from which existing theories emerge as approximations, limits, or partial descriptions. The first path begins with theories and seeks to reconcile them. The second begins with reality and intuitively seeks the common process.

The present work chooses the second path. It does not primarily attempt to unite the equations of General Relativity formally with those of Quantum Mechanics. It seeks to determine whether there is a deeper physical level capable of generating both relativistic geometric behavior and discrete, wave-like, or quantum behavior. *In other words, the question is not only how two theories can be united, but which common reality makes them possible.*

This change in method is important. If one starts from theories, one automatically inherits their fundamental concepts: particle, field, space–time, operator, metric, curvature, and probability.

If one starts from a deeper physical process, these concepts can be reinterpreted as effects rather than starting points. They do not disappear, but their position in the hierarchy of explanation changes.

In this sense, a unifying theory must not destroy current theories, but explain why they work. General Relativity must remain correct within its domain. Quantum Mechanics must remain correct within its domain. The Standard Model must remain correct within its domain. The novelty would lie in identifying a deeper level at which these domains no longer appear as separate theories, but as different regimes of the same reality.

This is the challenge of the Unified Theory. It must show that notions such as matter, field, geometry, information, interaction, and time can be reordered within a common framework—not by eliminating them, but by changing their status. What is now taken as fundamental may become a manifestation. What is now regarded as abstract may acquire a physical substrate. What is now separated into domains may be viewed as the expression of the same process in different regimes.

This reordering cannot be accepted merely by assertion. It must be demonstrated gradually. Therefore, the following chapters will not begin from the conclusion that the theory is true, but from testing the proposed mechanism. If a common physical substrate exists, it must be able to explain system, flow, coherence, geometry, adaptation, cycle, interaction, and the limits of stability. If it cannot, the hypothesis must be modified or abandoned.

The limits of current theories thus become the starting point of the new construction. Not because current physics has failed, but because its success has brought research to a frontier where questions can no longer be resolved merely by separating domains. A change of level is required. It is no longer enough to describe what matter, fields, or geometry do. We must ask whether matter, fields, and geometry can be expressions of a common process.

[D] Criterion for the foundational limit

A theory can be highly precise within its domain without providing the ultimate level of reality. The limitation of current physics lies not in a lack of results, but in the absence of a common substrate that simultaneously explains the emergence of matter, fields, geometry, time, and interactions as regimes of the same physical reality.

3.9. The methodological reversal — from unifying theories to deriving regimes

After the limitations of current theories have been identified, the problem of unification can be formulated more precisely. It is not enough to seek a more general equation that formally includes existing theories. Such a strategy begins with the final results of different domains and attempts to make them compatible. It works with mature theories, but also inherits the divides between them.

Another strategy is possible: not the direct unification of theories, but their derivation from an antecedent physical level. In this approach, established theories are not treated as absolute starting points, but as effective descriptions of particular regimes. General Relativity, Quantum Mechanics, thermodynamics, field theory, and fluid mechanics are not rejected, but repositioned. They become different windows onto a deeper process.

This is the methodological reversal proposed here. Instead of asking how two already-formulated theories can be united, it asks what type of physical reality could produce, under different conditions, the behaviors described by those theories. The emphasis thus shifts from making formalisms compatible to identifying the generating mechanism.

The difference is important. If research begins with existing theories, it is compelled to accept their basic concepts as fundamental: particle, field, space–time, state, operator, curvature, quantum, and probability. If it begins with an antecedent physical mechanism, these concepts can be reconstructed as effects. They do not disappear, but are no longer considered the ultimate elements of reality. They become forms in which a deeper level manifests itself.

In such a method, the central question is no longer: how can gravity be unified with quantum mechanics? The question becomes: what common process can generate both gravitational geometry and quantum behavior? The search is no longer merely for a bridge between two theories, but for a common source from which both can emerge as approximations.

This change imposes a stringent criterion. A mechanism proposed as a foundation cannot be accepted merely because it is suggestive or has intuitive value. It must produce recognizable regimes. It must be

able to explain why, at certain scales and under certain conditions, reality appears as continuous geometry, whereas under other conditions it appears as a discrete, wave-like, or quantized phenomenon. It must explain why stability, localization, interaction, conservation, and transformation arise.

Therefore, the theory cannot be limited to a general statement about a substrate or a fundamental flow. It must show how one passes from that level to observable phenomena. If a common mechanism exists, it must have generative power. It must produce structures, not merely name them. It must impose constraints, not merely permit analogies. It must provide criteria of stability, not merely images.

This requirement separates the physical hypothesis from metaphor. A metaphor may say that the Universe resembles a flow. A physical hypothesis must show what flows, how it is organized, what is conserved, what is transformed, what limits arise, and how the effects of this flow can be recognized in theories that have already been validated. Only the latter can enter a scientific framework.

At this point, the Unified Theory proposes a working hypothesis: at the fundamental level, reality must be analyzed as a process of geometrodynamics organization, capable of producing stable forms through adaptation, conservation, and interaction. This process is introduced not as a mere image, but as an object of verification. The entire volume must test whether such a hypothesis can support the transition from intuitive pattern to functional principle.

The methodological inversion also has a consequence for language. Instead of beginning with finite objects, it begins with the conditions of their emergence. Instead of beginning with abstract fields, it seeks the process that might organize them. Instead of beginning with geometry as a fundamental given, it seeks the mechanism that produces geometry. Instead of beginning with time as an external parameter, it seeks the internal transformation that makes time measurable.

This repositioning is not a rejection of mathematics. On the contrary, it calls for more disciplined mathematics, because every concept must be connected to a physical process. Mathematics is not abandoned, but it must no longer be the first reality. It becomes the language through which the relationships of a mechanism already defined physically are expressed. Before complete formalization, it must be established what is being formalized.

A unifying theory constructed in this way must satisfy several conditions. It must have a fundamental object of analysis. It must define the quantities that preserve its identity. It must explain how limits, interactions, and transitions arise. It must be able to describe both stability and the loss of stability. It must be able to show how a microscopic regime can produce macroscopic effects without a conceptual break.

This list of requirements becomes the criterion for selecting the central hypothesis. If the helical vortex tube is later proposed as a minimal geometrodynamics system, it must satisfy these requirements. It is not enough for it to be a form frequently found in nature. It must be able to function as a unit of analysis: it must have a boundary, an axis, flow, coherence, transport capacity, a mode of adaptation, a regime of interaction, and conditions of decoherence.

In this sense, the methodological inversion prepares the technical part of the work. Thus far, patterns, systems, processes, methods, historical vortices, geometrization, and the limits of current theories have been discussed. From this point onward, the question becomes more stringent: what is the minimal structure capable of linking all these directions into a verifiable physical mechanism?

The answer cannot be given through a declaration. It must be constructed. First, the minimal system is defined. Then its geometry is described. Next, the conserved quantities are established. Then adaptation is analyzed. Then interactions. Then transitions. Only after this sequence can it be discussed whether existing theories may be reinterpreted as particular regimes of the same mechanism.

This order is important because it avoids a common error in speculative theories: the conclusion is asserted before the mechanism is constructed. In the present approach, the conclusion must be deferred. The theory must not claim from the outset that it explains everything. It must show, step by step, what it can explain, where it requires completion, and where it encounters limits.

The methodological inversion is therefore not merely a change of vocabulary. It changes the criterion of validation. A theory is no longer evaluated only through the beauty of its formalism or its ability to cover several domains symbolically, but through its ability to generate distinct physical regimes from the same fundamental architecture. This is the mature form of unification: not joining theories at the surface, but deriving them from a common structure.

From this perspective, General Relativity and Quantum Mechanics need not be forced to become identical. They may remain different descriptions, suited to different regimes. What must be sought is the level at which the difference between them no longer appears as incompatibility, but as a separation

between manifestations of the same process. One describes global geometric behavior. The other describes the discrete, local, or wave-like behavior of structures. The question is whether both can arise from a deeper geometrodynamics.

This formulation allows unification without simplistic reductionism. It does not claim that gravity is ‘merely’ a vortex or that a particle is ‘merely’ a spiral. Such a reduction would be insufficient. It states, more cautiously and rigorously, that certain gravitational, quantum, and structural regimes could be different expressions of a common geometrodynamics that must be defined and verified.

Therefore, the methodological inversion represents the true threshold of Volume II. From this point onward, the discussion is no longer merely about history, intuition, or criticism of existing theories. It concerns the construction of a verifiable alternative. If the hypothesis of geometrodynamics flow is correct, it must produce structures, invariants, and transitions. If it does not, it cannot be retained as a foundation.

This requirement is essential to the rigor of the work. A new theory does not prevail by opposing older theories, but through its ability to explain why the older theories have been successful and why they have limits. It must preserve what is valid, explain what is incomplete, and offer a path toward extension. Only in this way can a paradigm shift become more than an assertion.

[H] Proposition of methodological inversion

Fundamental unification should not be sought solely by making existing theories compatible, but by identifying a common physical mechanism from which those theories can emerge as particular regimes. A new theory becomes relevant only if it can derive structures, limits, interactions, and transitions from the same basic architecture.

3.10. Criteria for a common physical substrate

A fundamental hypothesis cannot be accepted merely because it offers a unifying picture. In physics, a picture becomes relevant only if it imposes conditions, produces consequences, and permits its limits to be tested. For this reason, before proposing a common physical substrate for reality, it must be established what such a substrate should be able to do.

The first criterion is explanatory continuity. A fundamental substrate must not function only within a restricted domain, but must allow transitions between domains. It must be capable of supporting different descriptions at different scales without introducing arbitrary discontinuities. If quantum phenomena arise at the microscopic scale, while stable forms and classical trajectories arise at the macroscopic scale, the proposed substrate must explain the transition between these regimes. Describing only one of them is not enough.

The second criterion is generative capacity. A foundation must not merely support phenomena, but produce them. It must show how stable structures arise, how they are delimited, how they interact, how they preserve their identity, and how they disappear. A fundamental reality unable to generate observable forms remains an abstract background. By contrast, a common physical substrate must contain mechanisms through which difference, motion, stabilization, and transformation become possible.

The third criterion is conservation. Every coherent natural structure preserves something during transformation. It may conserve energy, momentum, charge, circulation, flux, topology, symmetry, or other characteristic quantities. A common physical substrate must explain why certain quantities are conserved and what role these conservations play in the emergence of identity. Without conservation there is no persistence; without persistence there is no object, system, or law.

The fourth criterion is geometric adaptability. Observable reality is not composed of immutable forms. Natural structures bend, stretch, compress, branch, close, fragment, or reorganize. A fundamental substrate must allow these transformations without the immediate loss of coherence. Form must be modifiable, but not arbitrary. It must respond to the constraints of the process that sustains it.

The fifth criterion is localization. A fundamental theory must explain why recognizable regions arise within a broader reality. If everything were perfectly homogeneous, no structures would exist. If everything were completely fragmented, there would be no continuity. The common substrate must allow regions of local coherence to emerge: regions that can be identified, tracked, and distinguished from their environment.

The sixth criterion is interaction. Structures do not exist separately. They influence, couple with, repel, combine with, break apart, or transform one another. A common physical substrate must include rules by which one structure can enter into a relationship with another. These rules cannot be mere

external descriptions; they must arise from the internal nature of the substrate. A fundamental interaction is not merely an exchange of effects, but compatibility or incompatibility between modes of organization.

The seventh criterion is the emergence of discreteness. The observable world displays both continuity and discontinuity. Fields appear continuous, yet energy, charge, spin, or certain states occur in quantized forms. A fundamental substrate must explain how discreteness can arise from a deeper process. If the foundation is continuous, it must be shown how it produces stable units. If the foundation is discrete, it must be shown how it produces continuity at large scales. Neither direction can be left without a bridge.

The eighth criterion is temporal orientation. A common physical substrate must be able to explain why natural processes have a history. Transformations are not merely reversible permutations of abstract states. Systems emerge, evolve, accumulate changes, reach their limits, and reconfigure. Therefore, the fundamental substrate must allow not only motion, but an evolutionary succession. Time must be linked to transformation, and transformation must be linked to a real change in the system's state.

The ninth criterion is compatibility with confirmed theories. A new hypothesis cannot ignore the success of existing theories. It must explain why they work within their domains. If a fundamental theory directly contradicts confirmed results without offering a better explanation, it cannot be retained. A common substrate must permit the recovery of known regimes: classical mechanics within its limits, relativity in the gravitational domain, quantum mechanics in the microscopic domain, and thermodynamics in the statistical domain.

The tenth criterion is conceptual testability. Not every fundamental hypothesis can be tested immediately by a direct experiment, especially if it concerns very deep levels of reality. But it must be testable through its consequences. It must indicate what should be observed if it is correct, what should not be observed, what its limits are, and what differences it produces relative to existing explanations. A hypothesis that can accommodate any result is not a theory, but an unconstrained interpretation.

These criteria form the filter through which any candidate foundation must be evaluated. They are not yet the theory itself, but the conditions for entering the theory. A common physical substrate must be generative, conservative, adaptive, localizable, interactive, capable of explaining discreteness, compatible with known regimes, and sufficiently clear to produce verifiable consequences.

Within this framework, the hypothesis of a geometrodynamical flow is introduced not as a philosophical picture of the Universe, but as a possible candidate for satisfying these criteria. It must show that it can produce regions of coherence, preserve invariants, generate geometry, explain interactions, and support transitions among different regimes of reality.

If a fundamental flow cannot do these things, it remains a metaphor. If it can, it becomes a possible physical substrate. The difference between the two situations is decisive. A metaphor resembles reality. A physical substrate produces observable reality through internal rules.

For this reason, the following chapters must not begin with the assertion that the substrate exists, but with an analysis of the conditions it must satisfy. The vortex tube, helical flow, state constants, interactions, and adaptation cycles will be introduced gradually precisely in order to test whether they can meet these requirements. Without such verification, the theory would not rise beyond the level of an extended analogy.

By establishing these criteria, the theory limits its own freedom. This is a necessary condition of rigor. An idea becomes stronger when it accepts constraints. If it can operate under these constraints, it gains consistency. If it cannot, it must be corrected.

Therefore, the common physical substrate must not be sought as a mysterious substance, a passive background, or a mere mathematical space. It must be sought as a mechanism capable of producing organization. What defines it is not only its existence, but its capacity to generate coherent structures, preserve identity, and transform difference into evolution.

Criteria for a common physical substrate

A common physical substrate may be proposed as a foundation only if it simultaneously satisfies the conditions of generation, conservation, localization, interaction, adaptation, compatibility with confirmed theories, and testability through consequences. Without these criteria, any unifying hypothesis remains an analogy, not a theoretical foundation.

3.11. Kinematic identity — from object properties to flow invariants

In conventional physics, the identity of an object is established through the properties that characterize it. A macroscopic body is identified by its form, mass, composition, position, and motion. A particle is identified by mass, charge, spin, and other quantum numbers. A field is characterized by its values, its symmetries, and the way it interacts.

This method is effective when objects or states can be clearly delimited. Yet it does not fully answer a deeper question: what makes a system remain the same during transformation? If its form changes, its internal material is renewed, and its geometry adapts, through what is its identity preserved?

The answer cannot be sought solely in the material or in the instantaneous form. In active natural systems, what persists is often a regime of organization. A flame, organism, river, or vortex remains recognizable not by preserving the same matter, but through the continuity of the process that sustains it. This continuity points to a deeper level of identity.

This level may be called kinematic identity.

Kinematic identity describes how a system preserves its distinctive character through organized motion. It answers not only the question ‘what is the system?’ but also ‘how does the system maintain itself as the same process?’ From this perspective, a system is identified not only by its instantaneous quantities, but by the relationships that remain stable during transformation.

Kinematic identity therefore introduces a criterion deeper than visible geometry. Two structures may have similar forms but different regimes of organization. Conversely, two structures may have different geometries but preserve the same set of fundamental ratios. In that case, they may belong to the same kinematic family.

In physics, this logic is already present in many forms. Conservation laws show that certain quantities remain stable during evolution. Symmetries show that certain properties do not change under transformations. Invariants allow the same reality to be recognized from different perspectives. The present theory adopts this lesson and applies it directly to coherent flows.

Rather than regarding the object as the primary carrier of properties, the Unified Theory regards coherent flow as the carrier of identity. Observable properties become expressions of a deeper kinematic regime. Mass, form, field, interaction, and stability are no longer treated as isolated givens, but as effects of the way in which the process organizes and preserves itself.

Here the role of the Preda constants emerges. They are introduced as characteristic quantities of geometrodynamics. They describe not merely a local value or an instantaneous form, but ratios that define a coherent flow's distinctive mode of existence. They must be understood as a signature of the kinematic state. This signature allows structures to be classified not only by their appearance, but by their mode of flow.

Two systems can interact deeply only if their kinematic states are compatible. If this compatibility exists, coupling, continuity, transfer, or composition may arise. If it does not, the interaction may produce instability, repulsion, decoherence, or reconfiguration.

Through this idea, interaction acquires a more precise meaning. It is not merely the encounter of two objects, nor merely the exchange of a quantity between two entities. It becomes a test of compatibility between two regimes of organization. When two structures meet, it is not only their forms that meet, but also their ways of preserving identity.

Kinematic identity also introduces a new understanding of transformation. A system does not become something else with every modification. It becomes something else when the invariants that define its regime can no longer be preserved. Up to that point, modifications are adaptations. Beyond that point, a change of state, loss of coherence, or the birth of a new identity occurs.

This distinction is important for the idea of evolution. Evolution is not merely an accumulation of changes, but a succession of adaptations around an identity that is preserved. When adaptation can no longer protect that identity, the system undergoes a transition. The emergence and disappearance of structures can thus be analyzed through the preservation or loss of kinematic invariants.

Within this framework, time acquires a deeper meaning. If identity is defined by what is conserved through transformation, then the evolution of a system cannot be described solely through the succession of external moments. It must also be described through internal changes in its kinematic state.

This observation prepares the transition toward the concept of space–time–cycle. If form describes spatial organization, and time describes the succession of transformations, the cycle describes the

system's position in its own history of adaptation. Kinematic identity thus becomes the bridge between the open system and the evolutionary cycle.

In conclusion, kinematic identity makes it possible to move beyond the simple opposition between object and process. The system is not merely an object, but neither is it an amorphous process. It is a coherent process that preserves invariants. These invariants allow it to be recognized as the same system despite change.

[H] Fundamental principle — kinematic identity

The deep identity of a natural system is determined not only by its matter, form, or position, but by the invariants that preserve its regime of organization during transformation. A system remains the same for as long as it can adapt its geometry without losing the kinematic signature that defines its coherence.

3.12. Space–time–cycle — the internal coordinate of the system's becoming

Chapter 2 defined the cycle as an internal variable of a system with a history of its own. Here the concept is not redefined, but integrated into the program of the volume: two systems may have similar geometries and chronological ages, yet occupy different stages of stabilization, adaptation, or loss of coherence.

The cycle is not a periodicity added to time. It describes repetition with accumulation and must be reconstructed from observable state thresholds. The helical representation intuitively expresses recurrence accompanied by displacement, but does not by itself constitute a physical demonstration.

Space describes configuration, physical time orders events, T_{gd} quantifies internal transformation according to the protocol, and the cycle locates the stage of the process. Separating these roles avoids using several words for the same quantity and prepares the normalized definition in Chapter 19.

For helical flows, the cycle permits comparison of states in different phases: genesis, stabilization, coupling, axialization, stress, or reconfiguration. Interaction depends not only on instantaneous geometry, but may also depend on the position of each flow in its own evolution.

[D] Definition of the cyclic coordinate

The cycle is the internal variable that expresses a system's position in its succession of states. It completes the geometric and temporal description only if it can be normalized, measured, and used to improve prediction of evolution.

3.13. The great challenge — testing the single key

The central question of this volume is whether a common architecture can explain the emergence of natural structures as coherent forms of process. The answer cannot be obtained through the recurrence of images, but through a controlled chain: system $\rightarrow$ flow $\rightarrow$ invariant $\rightarrow$ interaction $\rightarrow$ transformation $\rightarrow$ prediction.

The first stage is the vortex tube. It must be analyzed as a minimal geometrodynamical system, not as a symbol: a delimited domain, axis, rotation, transport, coherence, and adaptation. Established concepts — vorticity, circulation, helicity, flux, and reconnection — provide the connection to fluid mechanics; the theory's own hypotheses must then be formulated on this basis, without replacing it.

The second stage is state identity. The Preda constants are proposed to describe relationships conserved within the declared class of coherent helical flows. They become relevant only if they can be measured independently, if they exhibit reproducible regimes, and if they add predictive power beyond standard fluid parameters.

The third stage is interaction. The kernels must transform the relative geometry and state of flows into a classification of outcomes: continuity, induction, aggregation, reconnection, or decoherence. The existence of a suggestive diagram does not prove completeness; this must be tested on new configurations and on cases lying between classes.

The fourth stage is extension toward light, particles, kinematic correlation, gravity, and cosmology. No local success automatically validates these bridges. Each domain requires the recovery of established equations and a measurable deviation of its own.

To avoid terminological inflation, the term ‘fundamental principle’ is reserved in this edition for a core of twelve ideas: systemic delimitation; functional openness; self-organization through transport; conservation of function through adaptation; kinematic identity; the minimal helical system; topological

memory; the geometrodynamic invariant; the extended interaction state; the variable scale; axialization; Space–Time–Cycle. The remaining, somewhat stronger statements are labeled as definitions, hypotheses, criteria, observations, or propositions, according to their logical role.

This hierarchy does not diminish the content of the theory; it separates its foundation from its consequences. A definition fixes the meaning of a term, a hypothesis accepts the risk of testing, a criterion establishes a rule of decision, and a proposition develops the consequences of the framework. Only ideas that organize the entire volume transversally remain fundamental principles.

[F] Criterion for testing the single key

A unifying key is validated only if the same architecture produces operational definitions, measurable invariants, classifiable interactions, and differential predictions in precisely delimited domains. Unity must be demonstrated as continuity of mechanism, not declared as a superficial identity.

Chapter 3 thus concludes the methodological introduction. The technical test begins here: first the vortex and its invariants, then state, interaction, memory, and limits. Extensions toward the other domains are legitimate only insofar as each preceding stage withstands verification.

4. The vortex and vortex tube — the geometrodynamic structure of helical flow

4.1. The birth of the vortex

A vortex arises when a flow can no longer remain a simple distribution of motion and begins to organize itself through rotation. Transfer no longer proceeds solely along a dominant direction, but curves, coils, and produces a recognizable rotating region. From that moment, the flow acquires a center, direction, core, periphery, and duration.

Water draining through an opening provides the simplest image. The difference in level produces flow, but the discharge is not always linear. Under certain conditions, the fluid converges toward the outlet region, acquires rotation, and organizes itself around an axis. Axial motion and circular motion arise together.

The same general mechanism can arise in air, smoke, rivers, flows behind obstacles, or unstable fluid masses. Wherever there are differences in pressure, density, temperature, velocity, or potential, the flow may be compelled to change its geometry. Most often, this change takes the form of organized rotation.

Clearly, a vortex is not a rotating solid body. The elements of the medium that compose it may be continually replaced, yet the rotational regime may persist. This distinguishes it from a wheel or a rigid disk. The vortex is an active form of flow, not a fixed material object.

Not every disordered motion is a vortex. A turbulent flow may contain many local rotations, but a coherent vortex is distinguished by organization. It has a central region, a periphery, a direction of rotation, and sufficient continuity to be identified as a structure.

In its elementary form, the vortex is a local rotation of flow. In its developed form, it can become a column, filament, or tube. This transition is decisive: the local vortex shows the emergence of rotation, whereas the vortex tube shows the continuity of rotation along a direction of transport.

[H] Hypothesis of vortex emergence

A vortex arises when a difference of state between two regions of a flow system also produces organized rotation. Through this rotation, the flow acquires a center, direction, core, periphery, and geometry of its own.

4.2. The observable vortex — natural forms of fluid rotation

The vortex is one of the dynamic forms that can be observed at very different scales. It arises naturally almost everywhere in the macroscopic world, in oceans, the atmosphere, and cosmic structures. The material changes, the scale changes, and the duration changes, yet the same general architecture remains recognizable: a flow that organizes itself through rotation around a central region.

In water, a vortex arises where the flow encounters an outlet, an obstacle, a difference in level, or a change in cross-section. In rivers, vortices arise near banks, behind rocks, or in regions where currents meet. Water shows directly how a difference between neighboring regions can produce local rotation.

In air, the vortex becomes visible through smoke, dust, vapor, clouds, or entrained bodies. Columns of smoke twist, heated air rises through convective motions, and atmospheric currents can concentrate rotation into tornadoes, cyclones, or local vortices. In these cases, rotation is not geometric ornament, but a mode of organizing the transport of mass, heat, moisture, and momentum.

In oceans, vortices can have large dimensions and long lifetimes. They transport warm or cold water, separate regions of different density, and participate in energy exchanges between the ocean and the atmosphere. Here, the vortex is no longer merely a local phenomenon, but a circulation structure.

Around obstacles, vortices arise through flow separation. A rock in a river, a wing, a building, or a vehicle locally alters the fluid regime and produces recirculation. In engineering, this property can be exploited or avoided: the vortex can intensify mixing and separation, but it can also produce losses, vibrations, or instability.

In plasma and ionized media, rotation becomes subtler because the flow couples with charges, currents, and fields. Filaments, loops, jets, and spiral structures arise. At cosmic scales, accretion disks and spiral structures show that matter attracted toward regions of potential does not always fall directly, but constructs rotating and oriented trajectories.

This recurrence does not by itself demonstrate the universality of the vortex. It does show, however, that the vortex is an essential natural object for the analysis of coherent flows. It arises where flow becomes capable of delimiting and organizing itself and of persisting.

Observation on vortex recurrence

The vortex arises in different media and at different scales whenever flow develops coherent rotation in order to redistribute differences in velocity, pressure, density, temperature, or potential. Its recurrence does not by itself prove universality, but makes it an essential natural object for the analysis of coherent flows.

4.3. The vortex as a region of organized rotation

A vortex is a region of a flow in which local motion acquires coherent rotation. The medium does not move only from one region to another, but follows curved trajectories around an axis, a center, or a region of dynamic minimum. Through this rotation, the flow differentiates itself from the surrounding medium.

The essential element of the vortex is not its outer form, but the organization of motion. A vortex may be wide or narrow, short or elongated, stable or transient, directly visible or invisible. What defines it is the participation of the elements of the medium in a common regime of rotation.

This rotation always has an orientation. There is a sense of winding, a local direction of motion, and a difference between the central and peripheral regions. Near the center, the flow may be accelerated, rarefied, drawn inward, stretched, or stabilized. At the periphery, it interacts with the external medium.

The vortex has a boundary, but this boundary is not a wall. It is a dynamic frontier. Within it, the flow participates in the common rotation. Outside it, the medium may have a different velocity, direction, or regime of motion. The vortex boundary is the boundary between two flow behaviors.

The vortex is volumetric by nature. A planar representation can show the direction of rotation, but it does not exhaust the phenomenon. Even when observed in cross-section, a real vortex has extension, depth, duration, and exchanges with the environment.

The coherence of the vortex depends on the ratio between internal rotation and external disturbances. If the environment feeds it compatibly, the vortex may persist. If the environment slows it, breaks it, or alters its geometry too strongly, the vortex disintegrates.

In the Unified Theory, the identity of the vortex is not reduced to its visible contour. A vortex may change its size, intensity, or form without immediately ceasing to be a vortex. What matters is the preservation of the coherent rotational regime.

[R] Proposition of organized rotation

A vortex is a region of flow in which local motion organizes rotationally around a core, an axis, or a dynamic center. Its identity is determined not by a rigid contour, but by the persistence of coherent rotation that differentiates the interior from the external environment.

4.4. *The vortex in the history of science — from whirlpools to physical structure*

The idea that nature can be understood through rotational motions of a medium is not new. Before modern physics formulated fields, differential equations, and quantum models, the vortex appeared as an intuitive image of a world in continuous motion. It offered a simple explanation for the organization of matter: wherever there are medium, motion, and rotation, stable structures can arise.

In Descartes's natural philosophy, the Universe was imagined as a plenum in motion, organized through whirlpools. Celestial bodies were viewed not as isolated objects in empty space, but as structures carried by large motions of a subtle medium. The model did not survive as a precise astronomical description, but it preserved an important idea: organized motion of the medium can produce cosmic architecture.

This intuition was superseded by Newtonian mechanics, where the emphasis shifted to bodies, forces, and trajectories. Space became the framework in which objects move, and the vortex lost its role as a general explanation of the world. Yet it did not disappear. It remained present in the study of fluids, where rotation could not be ignored.

The decisive moment came with Hermann von Helmholtz. Through his analysis of vortices in ideal fluids, the vortex ceased to be merely an intuitive image and became a rigorously described physical object. The vortex line, vortex tube, and persistence of rotational flow thus entered the language of science. The vortex acquired an identity of its own within the fluid: it is neither a solid body nor mere disorder.

This change is essential. A fluid can flow without producing a distinct structure. But when a region of fluid preserves its rotation and organizes around vortex lines or tubes, an identifiable dynamic form emerges. Helmholtz showed that the vortex can be treated as an entity of flow even though it has no material walls.

Lord Kelvin took this idea in a bolder direction. He proposed that atoms were stable vortex configurations in a continuous medium. In this view, matter was composed not of hard points, but of persistent structures of flow. The atom became a stable form of motion, not an ultimate piece of substance.

The vortex-atom theory did not become the accepted model of matter. Chemistry and atomic physics followed other directions. Nevertheless, its conceptual importance remains considerable. For the first time, matter was coherently conceived as a stable form of a process. The identity of the particle was no longer sought in a rigid object, but in a persistent organization of motion.

Peter Guthrie Tait, continuing along this path, attempted to classify the possible forms of these structures. Although the original program was abandoned, the idea that stability may belong to a configuration, not only to a substance, remained active in physics. The vortex thus became a meeting point among flow, form, and persistence.

Maxwell, in turn, used mechanical models based on rotations and vortices to develop his intuitions about electromagnetism. These models are no longer considered descriptions of the actual electromagnetic field, but they played a heuristic role. They showed that rotation, stress, and the transmission of motion through a medium can help illuminate field phenomena.

Through these authors, the vortex underwent an important transformation. It began as a cosmological image, became a fluid structure, then a hypothesis for matter and an intuitive model for fields. Although each stage had its limits, the general direction remained clear: the vortex allows us to conceive a reality in which form is not separate from motion.

The Unified Theory revisits this question from a geometrodynamic perspective. The vortex is treated not as a historical relic, but as the first structure in which flow, rotation, boundary, and persistence can be analyzed together.

[R] *Proposition on the continuity of the vortex in the history of physics*

The vortex has recurred throughout the history of science because it provides a form through which motion can acquire structure, and structure can acquire persistence without becoming a rigid object.

4.5. *From the classical vortex to the modern vortex*

In classical fluid mechanics, the vortex appears as a region of rotation in a material fluid. It can be observed in water, air, or gases and can be produced by differences in pressure, shear, obstacles, or

motions imposed externally. In this form, the vortex seems bound to the visible, continuous, macroscopic world.

Modern physics, however, has greatly extended this picture. The vortex no longer appears only in ordinary fluids, but also in media in collective states of organization: superfluids, quantum condensates, superconductors, plasmas, and ordered fields. In these media, rotation is not merely local motion, but can become a stable structure of the entire system.

A decisive example is provided by superfluids. In an ordinary fluid, rotation can be distributed continuously and dissipated through friction. In a superfluid, rotation arises through well-defined filamentary structures with discrete circulation. The system does not rotate arbitrarily, but through the emergence of vortical units.

This observation changes the status of the vortex. It is no longer merely a secondary phenomenon of flow, but a mode through which a coherent medium admits rotation without losing its global order. In such a regime, the vortex becomes an element of organization, not merely a sign of instability.

In Bose–Einstein condensates, vortices can form regular lattices. In superconductors, magnetic-field penetration can take a filamentary form. In plasmas, charges, fields, and flows can generate loops, jets, and filaments. In all these cases, rotation is concentrated into persistent structures.

This transition from the classical vortex to the modern vortex is important because it shows that organized rotation does not belong exclusively to visible fluids. It also appears where matter behaves collectively, where fields possess coherence, and where motion can no longer be reduced to the independent displacement of particles.

A vortex in water and a quantum vortex are not the same phenomenon. They belong to different physical regimes. Nevertheless, both show that media in motion can produce persistent rotational structures. The difference concerns the substrate, scale, and particular laws of the medium, not the disappearance of the principle of organization through rotation.

Observation on the extension of the vortex

The vortex does not belong exclusively to classical fluids. In coherent media, rotation can organize itself into distinct, stable, and oriented structures, becoming a general form through which physical systems manage motion without losing global coherence.

4.6. Regimes of vortex existence

The vortex does not have the same nature in every medium. Its general form may be similar, but the physical substrate of rotation differs. In an ordinary fluid, the fluid mass rotates. In a superfluid, the common phase of the system is organized. In a plasma, the motion of charged particles couples with electromagnetic fields. In an ordered field, rotation may belong to its internal orientation.

The first regime is that of classical vortices. This includes vortices in water, air, gases, and engineering fluids. They arise through differences in velocity, pressure, or density, or through constraints imposed on the flow. Rotation is directly associated with the displacement of the material medium.

The classical vortex is, in most cases, dissipative. It consumes the difference of state that produced it and decays when its supply disappears or when internal friction destroys its coherence. Its persistence depends on environmental conditions.

The second regime is that of coherent vortices in collective quantum media. In superfluids and condensates, rotation is not distributed freely, but arises through distinct, filamentary structures with well-defined properties. The vortex becomes a coherent defect of the medium.

The third regime is that of electromagnetic and plasma vortices. In a plasma, charged particles respond to fields, and the fields are altered by the motion of the particles. A rotational structure can be simultaneously material, electric, and magnetic.

The fourth regime is that of field or orientation vortices. In systems with internal order parameters, what rotates is not necessarily a visible fluid mass. The direction of orientation, phase, polarization, or the internal configuration of the system may rotate.

There are major differences among these regimes. The classical vortex depends on viscosity and continuous feeding. The quantum vortex depends on the global coherence of the medium. The plasma vortex depends on coupling between particles and fields. The orientation vortex depends on the internal order of the material.

Nevertheless, the same general feature appears in every case: a state of the medium organizes through rotation around a region or axis. This classification prevents the vortex from being reduced to a single example and allows it to be used as an object of general analysis.

Observation on vortex-type regimes

The vortex manifests differently according to the physical substrate of rotation. In classical fluids it is rotational flow; in quantum media, a discrete coherent structure; in plasma, coupling between flow and field; and in ordered systems, a persistent deformation of internal order.

4.7. Vortex genesis — classical mechanisms and the sink/induction hypotheses

Within the model's internal taxonomy, genesis is grouped into two categories: sink and induction. These do not exhaust the mechanisms of fluid mechanics, where vorticity may also be generated or reorganized through shear, boundary conditions, stretching and tilting of vorticity, or baroclinic effects. The 'sink' category describes convergence toward a central region, while 'induction' describes entrainment by a neighboring motion or flow.

Genesis through a sink may occur when there is an outlet, a pressure deficit, or a potential difference, and the flow converges toward that region. Convergence alone does not produce rotation: initial angular momentum, a disturbance, an asymmetry, or a mechanism for generating vorticity is required. When these conditions are present, the center collects, the periphery supplies, and the flow can wind around the outlet axis.

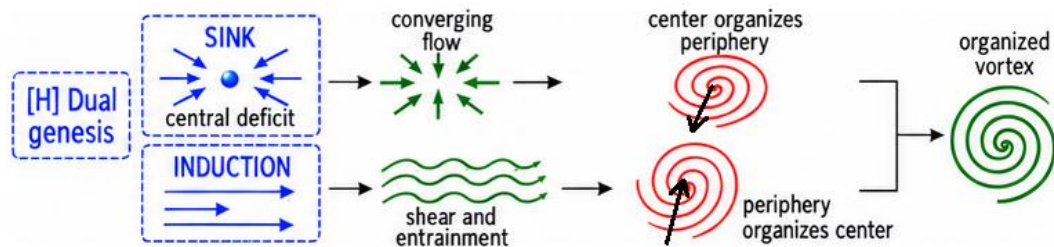
In this type of genesis, the center is the active element. It establishes the general orientation of the flow and concentrates the motion. The vortex develops as the medium progressively approaches the axis. Rotation is not imposed from outside, but arises as an organization of the convergent flow.

Genesis through induction follows a different logic. Here, rotation begins not from a central sink, but from interaction between regions in different states of motion. Two layers of fluid with different velocities, a flow passing an obstacle, or a mass of air entrained by neighboring currents can produce a shear region.

In genesis through induction, the periphery is the active element. Motion is transmitted from the exterior toward the region that begins to rotate. The center does not exist as a sink from the outset, but emerges gradually through the organization of rotation. The vortex forms through entrainment, rolling, and the progressive concentration of motion.

In the language of fluid mechanics, these two situations approximate the distinction between a free vortex and a forced vortex. The free vortex is dominated by the convergence of flow toward the center. The forced vortex is dominated by fluid entrainment through an external action. In nature, the two forms rarely occur in a pure state.

This distinction is important because rotation does not have a single origin. It may be produced by a central potential difference or by a lateral difference in motion. Both mechanisms transform imbalance into rotation and rotation into structure.



[H] Proposition of dual vortex genesis

A vortex may be born through a sink, when a central region attracts and concentrates the flow, or through induction, when an external motion entrains the medium and produces rotation. In the first case, the center organizes the periphery; in the second, the periphery organizes the center.

4.8. Anatomy of the vortex — core, axis, direction, and chirality

A vortex has a simple but essential internal architecture. It can be recognized through several elements: core, axis, periphery, dynamic boundary, axial direction, and chirality. These elements are not rigid parts, but functional regions and orientations of the flow.

The core is the central region around which rotation is organized. It may be a region of low pressure, an area of altered velocity, an outlet line, a rarefied region, or the kinematic center of motion. The core must not be confused with a material object located at the center of the vortex.

The axis is the principal direction of vortical organization. In a short vortex, it may be only the local direction around which the flow rotates. In an elongated vortex, the axis becomes clearer and establishes the direction along which rotation extends. The axis may curve, tilt, oscillate, or adapt to the environment.

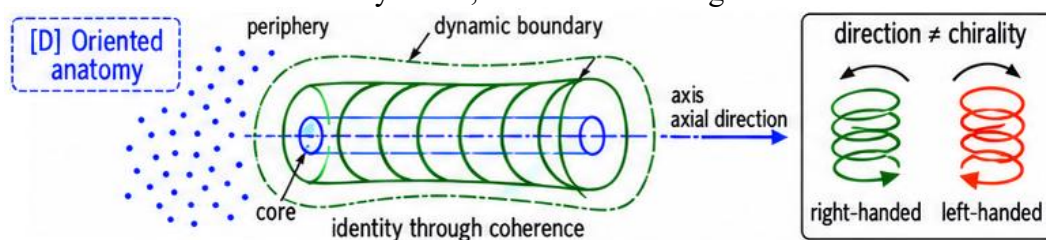
Every vortex also has an axial direction. This indicates the orientation of flow along the axis. In a tornado, this direction can be described simply as top-to-bottom or bottom-to-top, depending on the orientation of axial IN–transport–OUT flow. Axial direction is not the same as rotation; it indicates the general direction of transport.

In addition to axial direction, the vortex has chirality. Chirality indicates how rotation winds relative to the selected axial direction. A vortex can be right-handed or left-handed, like a screw that advances according to its direction of rotation. Chirality is correctly established only after the axial direction of flow has been selected.

This distinction is essential. Two vortices may have the same contour but different axial directions. Likewise, two vortices may have the same axial direction but opposite chirality. In the first case, transport is oriented differently. In the second, transport may be oriented alike, but the winding of rotation differs.

The periphery is the region where the vortex comes into contact with the external medium. Looking toward the ends, this is where feeding or discharge occurs. Looking toward the boundary of the core, we observe lateral interaction, entrainment or braking, shaping, or even dissipation of the structure. The dynamic boundary separates the internal rotational regime from that of the surrounding medium. It is not a wall, but a behavioral frontier.

The vortex's stability does not come from a fixed form, but from maintaining the relationship among core, axis, axial direction, chirality, periphery, and boundary. If these relationships remain coherent, the vortex can withstand deformation. If they break, the vortex disintegrates.



[D] Definition of oriented vortex anatomy

A vortex consists of a core, axis, axial direction, chirality, periphery, and dynamic boundary. Axial direction indicates the direction of transport, while chirality indicates the winding of rotation relative to that direction. The vortex's identity depends on the coherence of these orientations.

4.9. From vortex to vortex tube — axial continuity of rotation

A local vortex may exist as rotation concentrated within a limited region. It has a core, direction, chirality, and periphery, but not necessarily clear development along its length. When this rotation extends in the direction of the axis, the vortex acquires axial continuity and becomes a vortex tube.

The vortex tube is not merely a longer vortex. It is a flow structure in which local rotation is maintained along a direction. The axis is no longer merely the reference for local rotation, but becomes a path. The core is no longer merely a center, but an axial thread. The periphery is no longer merely an edge, but the dynamic envelope of an extended flow.

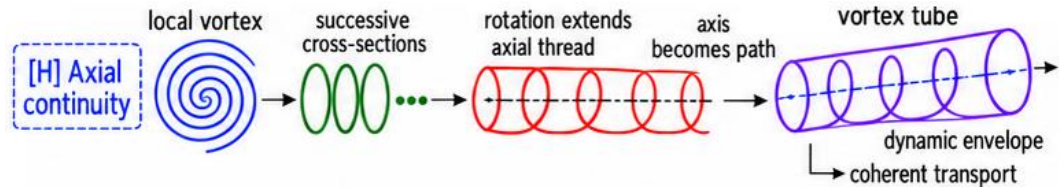
This transition changes the nature of the phenomenon. The local vortex expresses the emergence of rotation. The vortex tube expresses the persistence of rotation. In the local vortex, flow organizes within a region. In the vortex tube, organization is transmitted from one cross-section to another.

A vortex tube has no material walls like a pipe. Its boundary is determined by the flow regime. Inside, the medium participates in the common rotation. Outside, the flow behaves differently. The tube is a channel of coherent rotation, not a solid object introduced into the fluid.

The tube's cross-section may vary. It may be wider in one region and narrower in another. The axis may curve, twist, or undulate. The periphery may deform. Nevertheless, the tube remains a tube for as long as rotation retains continuity along its path.

The tube has two simultaneous aspects. In cross-section, it appears as rotation around a core. Along its length, it appears as an oriented structure. If rotation disappears from the cross-section, the tube no longer has vortical content. If axial continuity disappears, the tube breaks into local vortices.

The difference between a vortex and a vortex tube can be stated simply: a vortex is rotation organized within a region; a vortex tube is organized rotation that acquires axial continuity. The vortex has a center; the tube has an axis. The vortex forms locally; the tube transports along a path.



[H] Proposition of axial vortex continuity

A vortex tube arises when the local rotation of flow extends along an axis and preserves its coherence from one cross-section to another. The vortex is local rotation; the vortex tube is rotation continued axially and capable of becoming a transport structure.

4.10. The vortex tube and vortex lines — constitutive organization

The vortex tube is not a homogeneous, simple, compact flow. It is a structure composed of smaller flows organized together. At the global scale, the tube appears as a single extended vortex. At the internal scale, it is a bundle of vortex lines.

In fluid mechanics, a vortex line is a geometric curve tangent at every point to the vorticity vector; it is not automatically a material filament or a ‘mini-vortex.’ [H] The Unified Theory adds the hypothesis that, for certain coherent flows with resolved internal structure, a filamentary region surrounding such a line can function as a constituent tube of a larger tube. This extension requires a scale, a vorticity profile, and an experimental criterion of individuation.

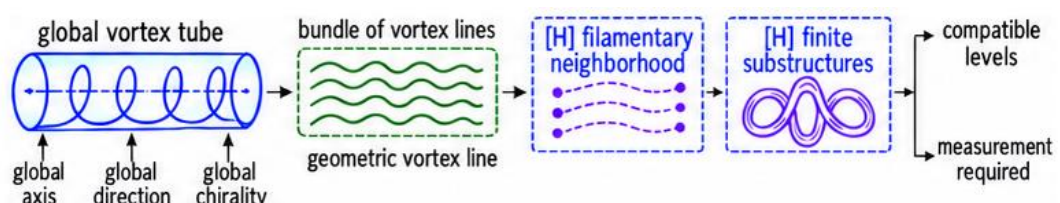
Thus, the vortex tube is the global structure, while vortex lines are its internal structures. The tube has a general axis, a general direction, and global chirality. The lines, in turn, have their own direction, winding, and contribution to the overall flow.

This distinction is important because a vortex tube is not maintained by a rigid outer surface. It is maintained through the internal organization of its lines. If the lines remain compatible, the tube persists. If the lines become disordered, break, or lose their synchronization, the tube loses its coherence.

[H] In the proposed extension, it is not the geometric line itself, but a filamentary neighborhood around it that could possess its own rotation and participate in local transport. The ensemble of these regions could construct the tube's global transport. This statement is a constitutive hypothesis, not a standard definition of the vortex line.

[H] The model explores a recursive organization: tubes with internal filamentary regions, which may display structures at finer scales, such as branches and subbranches. Recursivity is not assumed to be infinite and does not follow from the geometric definition of the vortex line; each level must be supported by a resolved scale and its own observables.

This recursivity does not mean identical repetition. The levels are not perfect copies of one another. Each level has its own scale, intensity, stability, and role within the whole. Sublines do not mechanically duplicate the main line, but support its coherence. Lines do not mechanically repeat the tube, but construct it.



[H] In the theory's internal vocabulary, the difference between the tube and its constituent filament is treated as a difference of level. The tube is the global structure, while filaments and possible

substructures are finer levels. This ontology remains hypothetical until the coupling dynamics are defined and the presumed levels are observed.

[H] *Proposition of constitutive organization*

In the proposed constitutive scheme, the tube is the coherent global structure, while the filamentary neighborhoods of vortex lines are treated as possible internal structures. These may have finite substructures, branches, and subbranches. Coherence would depend on compatibility among the levels, a hypothesis that must be expressed through equations and measurements.

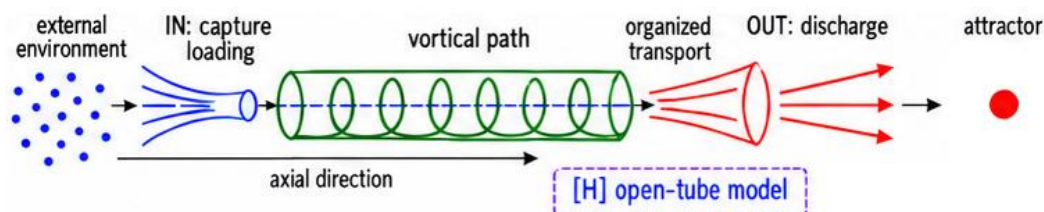
4.11. The ends of the vortex tube — IN, path, and OUT

A vortex tube has a functional orientation. It is not merely an extended rotation, but a flow structure that receives, organizes, and conducts. From this perspective, the tube has three fundamental regions: IN, vortical path, and OUT.

IN is the region through which the flow enters vortical organization. Here, matter, energy, momentum, or information is captured from the external environment and introduced into a coherent regime of rotation. IN may be a broad collection region, a capture surface, a region of convergence, or a domain in which the potential difference begins to orient the flow.

The vortical path is the region in which the flow preserves its organized form. Here, rotation, axial direction, chirality, and the tube's internal coherence are maintained. The path is not a rigid conduit, but a dynamic region of transport. The axis may curve, the cross-section may change, and the periphery may adapt.

[H] In the open IN–path–OUT scheme, OUT is the oriented region through which the flow is transmitted toward a collection, accumulation, or transfer region called the attractor. This is a functional convention of the model, not a universal property of all vortex tubes; closed vortex rings and tubes that reach boundaries or extend to infinity require separate treatments.



This clarification is essential. The vortex tube must not be understood as a flow that enters through one end and is lost through the other. It is an oriented structure between a capture region and a region of attraction. IN collects the flow, the path organizes it, and OUT conducts it toward the attractor.

In the particular case of an open sink, IN is the region from which the fluid is drawn, the path is the region of concentration and winding, and OUT is the direction of discharge toward the region of lower potential. This description does not automatically extend to every vortex and assumes boundary conditions and an explicit mass balance.

IN and OUT are not mere geometric ends. They are transport functions. IN defines how the tube receives the flow. OUT defines the direction in which organized flow is conducted toward the attractor. Between them, the path preserves vortical identity.

The tube's stability depends on continuity among these three regions. If IN no longer feeds the flow, the tube weakens. If the path loses coherence, transport fragments. If OUT is no longer compatible with the attractor, the flow becomes blocked, deforms, or reconfigures.

Hypothesis — IN–OUT orientation toward the attractor

A vortex tube is defined by IN, path, and OUT. IN captures flow from the external environment, the path organizes it vortically, and OUT conducts it toward the attractor. The tube's identity depends on the oriented continuity among capture/loading, transport, and evacuation/discharge.

4.12. Coherence of the vortex tube — geometry as a variable of adaptation

A vortex tube does not preserve its identity by maintaining a fixed form. On the contrary, its form changes so that the tube can preserve its coherence. Geometry is the variable that adapts, while coherence is the condition that must be conserved.

This distinction is essential. If the tube attempted to preserve its geometry rigidly, it would break at the first significant change in its environment. Real flow does not encounter perfect conditions. IN may vary, the attractor may alter the intensity of capture, the external environment may introduce lateral pressures, and the constitutive lines may receive different disturbances.

Coherence therefore exists at the expense of fixed geometry. The axis may curve to avoid breaking. The cross-section may narrow or widen to regulate transport. The periphery may undulate to absorb differences in motion relative to the environment. Vortex lines may rearrange locally to preserve the compatibility of the whole.

A coherent tube is not perfectly straight, perfectly cylindrical, and perfectly uniform. That is only an idealization. A real tube is an adaptive structure. It changes its form to preserve the relationship among IN, path, and OUT, between constitutive lines and the global axis, and between axial direction and dominant chirality.

The first element that adapts is the axis. It is not a geometric rod, but the mean direction of transport. If the environment imposes a deviation, the axis curves. If the attractor moves or the optimal path changes, the axis changes its orientation. As long as transport remains coherent toward the attractor, the change in the axis does not destroy the tube.

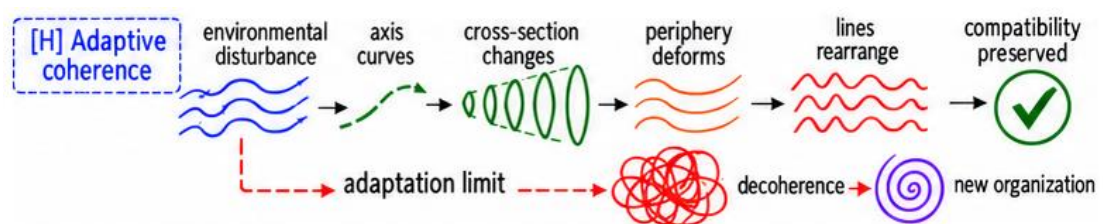
The second adaptive element is the cross-section. The tube may narrow when the flow is concentrated and widen when transport is distributed. This variation is not a loss of identity, but an adjustment. The cross-section need not remain constant; it must remain compatible with internal transport.

The third adaptive element is the periphery. It directly receives the influence of the external environment. It may be compressed, stretched, deformed, or locally destabilized. If the constitutive lines can absorb these changes without losing their common regime, the tube remains coherent.

Vortex lines are the most important level of this adaptation. They are not rigid threads, but constituent vortices capable of repositioning themselves, moving closer together or farther apart, or locally changing their path. The global tube is maintained through the ability of these lines to change their geometry without losing kinematic compatibility.

Decoherence occurs when geometry can no longer compensate for disturbances. If the axis breaks, if the constitutive lines become incompatible, if axial direction fragments, or if OUT can no longer flow toward the attractor, the tube loses its identity. At that moment, geometry can no longer preserve coherence.

This loss does not mean that motion disappears. Flow continues, but the old tube no longer exists as a coherent system. Its lines may separate, branch, regroup, or form other tubes. The former vortical identity is lost, and the possibility of a new organization arises.



[H] Proposition of coherence through geometric adaptation

In the Unified Theory, the vortex tube preserves its coherence by adapting its geometry. The axis, cross-section, periphery, and constitutive lines may change in order to maintain flow compatibility among IN, path, and OUT. Geometry is the adaptive variable; coherence is the conserved condition.

4.13. The vortex tube, the minimal helical geometrodynamical system

Within the model, the vortex tube is proposed as the minimal structure in which flow, rotation, orientation, and transport can be analyzed together. In fluid mechanics, it is a tubular region bounded by vortex lines; its additional organization into filaments, substructures, branches, and subbranches remains a constitutive hypothesis of the Unified Theory.

Through this organization, the vortex tube becomes a minimal helical geometrodynamical system. It has a core, axis, axial direction, chirality, periphery, and dynamic boundary. It has IN, path, and OUT. Through IN it captures flow from the external environment, along the path it organizes that flow, and

through OUT it flows toward the attractor. Between these regions, geometry adapts so that the system can preserve its coherence.

The tube's minimal character does not mean absolute geometric simplicity. It means that all the elements required by a geometrodynamical system are already present: delimitation, interior, exterior, transport, orientation, adaptation, and coherence. A simpler structure may have local rotation, but it does not yet have a complete transport organization. The vortex tube has this organization.

A vortex tube must not be understood as an isolated object. It always exists within an environment of evolution. The environment feeds, constrains, slows, deforms, or stabilizes it. Differences in pressure, density, temperature, velocity, potential, or state are not external decoration, but conditions that participate directly in the tube's existence.

For this reason, a helical geometrodynamical system cannot be analyzed by completely separating the tube from its environment. The tube has an identity of its own, but this identity is maintained through exchange with the exterior. It is not independent of its environment, but coherent within it. Its persistence depends on compatibility between the internal regime and external conditions.

A helical geometrodynamical system must be described on two complementary levels. The first is the internal level: the tube's own regime, determined by its axis, axial direction, chirality, constitutive lines, IN, path, OUT, and geometric adaptation. This level expresses the system's internal state and prepares the formulation of a state equation specific to helical flow.

The second is the external level: the way in which the tube enters into a relationship with the environment or with other helical systems. Here, describing internal state is no longer sufficient. The fundamental forms of coupling must be defined, namely those interaction kernels through which the system can induce, transmit, attract, align, deflect, multiply, or destabilize other flows.

Thus, the internal state relation describes the tube's own identity, while the interaction kernels describe its behavior at the boundary in relation to the exterior. The former belongs to the system's interior; the latter belong to the relationship between the system and its environment. Together, they allow the vortex tube to be treated not as an isolated object, but as an open system capable of preserving its internal coherence while interacting with the exterior.

The same rule applies to the relationship among different tubes. A vortex tube may evolve alongside other tubes, be influenced by them, induce rotation in the neighboring medium, or be attracted, repelled, deflected, aligned, branched, or destabilized. Helical flow does not produce completely singular structures, but systems capable of entering into relationships.

Interaction between two helical systems depends not only on their spatial proximity. It depends on direction, chirality, axial orientation, intensity, transport regime, and compatibility of their constitutive lines. Two nearby tubes may remain independent, couple, deform each other, or obstruct one another. The medium between them becomes an active part of the interaction.

In the Unified Theory, no helical geometrodynamical system is analyzed as an absolutely isolated entity. Isolation can be used only as a local approximation. In reality, each tube exists within a field of conditions, influences, and interactions. It is a system because it can be delimited, but it is a natural system because it remains open.

This openness changes the way stability is understood. A stable tube is not one that does not interact, but one that can interact without losing its coherence. An unstable tube is not merely one that is deformed, but one whose geometry can no longer compensate for the actions of the environment or of other helical systems.

The vortex tube thus becomes the starting point of geometrodynamical analysis. Through it, one can track how a coherent structure arises, how transport is organized, how orientation is conserved, how geometry adapts, and how the system enters into a relationship with its environment and with other structures of the same type.

From this perspective, the local vortex is the initial form of organized rotation, while the vortex tube is the complete form of coherent helical transport. It is the minimal system through which flow becomes architecture and architecture becomes interaction.

[H] Fundamental principle — the minimal helical geometrodynamical system

The vortex tube is the minimal helical geometrodynamical system because it unites flow, rotation, axial direction, chirality, constitutive lines, IN, path, and OUT toward the attractor within a coherent transport structure. It does not exist in isolation, but within an environment of evolution and in a possible relationship with other helical systems. The tube's internal state prepares the state relation, while its

relationship with the exterior prepares the interaction kernels. Its coherence depends on adapting its geometry to these conditions and interactions.

5. Invariants of the vortex tube — conservation, memory, and the ideal limit of helical flow

5.1. From the vortex tube to the problem of conservation

In the preceding chapter, the vortex tube was defined as the complete form of coherent helical flow. It is not merely a local region of rotation, but an oriented structure with an axis, axial direction, chirality, constitutive lines, IN, path, and OUT toward the attractor. Through these elements, the vortex tube becomes the first minimal geometrodynamical system: it has an interior, exterior, dynamic boundary, transport, adaptation, and coherence.

Yet this definition immediately raises a deeper problem. If the vortex tube is not a rigid object, if it has no fixed material walls, and if the matter traversing it can change continually, then what remains the same when the tube stretches, contracts, curves, narrows, thickens, branches, or changes its path?

The answer cannot be sought in the visible form of the moment. Instantaneous form is merely the temporary expression of a flow state. A coherent tube can have variable geometry without immediately losing its identity. The axis may oscillate, the cross-section may change, the dynamic perimeter may be deformed, and the constitutive lines may undergo local adjustments. *If the flow regime remains coherent, the tube continues to be the same system even though its geometric image has changed.*

This gives rise to the need for invariants. The invariant is what the system preserves during transformation. It describes not transient form, but the system's deep continuity. In a rigid geometry, identity appears to be determined by the contour. In a helical flow, identity must be sought in the quantities that remain stable while the contour changes.

This difference is essential to the Unified Theory. The vortex tube is not an object that moves, but an organized motion that produces a dynamic object. Conservation therefore cannot be reduced to preserving a form. It is necessary to analyze what is conserved in the regime of motion, in the distribution of rotation, in the continuity of vortex lines, in their internal linking, in the flux traversing the tube, and in the topological memory of the whole.

A coherent vortex tube can adapt geometrically precisely in order to conserve these quantities. If the external environment compresses it, the tube can change its cross-section. If the path is deflected, the axis can curve. If a disturbance arises in a peripheral region, the constitutive lines can locally redistribute geometric stress. *Coherence is preserved not through immobility, but through controlled transformation.*

In this sense, visible geometry is the effect, while the invariant is the substrate of identity. Geometry shows the system's momentary state; the invariant shows its continuity. Without an invariant, the tube would be merely a transient form. With an invariant, the tube becomes a recognizable system capable of passing through its own transformations without immediately losing its identity.

In fluid mechanics, this problem has been formulated through quantities such as vorticity, circulation, vorticity flux, and helicity. These are not merely mathematical concepts, but tools through which organized rotation can be tracked beyond the visible form of flow. They allow a vortex to be described not as an image, but as a dynamic structure. [8]

In the Unified Theory, these quantities constitute the first level of analysis. They describe the physical and topological basis of the vortex tube. Yet they do not exhaust the entire geometrodynamical identity of helical flow. Beyond them, specific quantities will be needed, capable of describing the internal state of flow, transport efficiency, coupling compatibility, and geometric adaptation. But before introducing these specific constants, the established foundation of conservation must be set out.

Thus, we begin not with a new hypothesis, but with a necessary question: what can remain constant in a vortex tube that changes its geometry? The answer begins with flow invariants. They are the bridge between the observable vortex and the deeper geometrodynamical system.

[H] Proposition of identity through invariance

A coherent vortex tube preserves its identity not by conserving a rigid form, but by conserving structural quantities during geometric adaptation. The visible form may change, but the invariant preserves the continuity of the system.

5.2. Ideal flow as the necessary limit of conservation

The study of vortex-tube invariants requires an approach toward the ideal flow regime. This approach must not be understood as a mere mathematical convenience or as a denial of real flows. In nature, real vortices are affected by friction, dissipation, turbulence, mass exchange, instabilities, and interactions with the environment. Yet if the purpose of the analysis is conservation, the limit in which these effects do not immediately destroy the coherence of the system must be investigated.

In this sense, the ideal regime is the necessary limit within which the tube's identity can be tracked. In a completely disordered flow, without continuity and internal coherence, one cannot rigorously speak of a persistent vortex tube. There are local rotations, fluctuations, instabilities, and mixing, but there is not yet a structure capable of conserving its parameters. For a vortex tube to become an object of fundamental analysis, it must approach a state in which losses do not immediately dominate organization.

Idealization does not artificially introduce coherence; it makes it analyzable. It separates what is essential to the tube's identity from what produces its local destruction. In a real regime, a vortex can arise and disappear rapidly. In a near-ideal regime, one can track what the flow tends to conserve as its geometry changes.

This distinction is important. It is not claimed that all natural vortices are ideal. It is claimed that a coherent vortex tube analyzed at a fundamental level must be treated near this limit, because only there can conserved quantities be clearly defined. Ideal flow is the limiting framework of conservation, not an object separate from reality.

Within such a framework, the matter traversing the tube need not remain the same. Fluid elements may enter through IN, be organized along the path, and be conducted through OUT toward the attractor. Nevertheless, the flow regime may remain recognizable. Identity belongs not to particular material particles, but to the organization of transport. The tube persists not because it retains the same matter, but because it retains the same type of coherence.

This idea is essential to geometrodynamical sinks. A sink must be understood not as a fixed object, but as a regime for capturing, organizing, and conducting flow. It may be fed continuously, exchange matter with the environment, and locally alter its geometry, yet it remains a system for as long as it preserves its coherence parameters. Near the ideal regime, the relevant duration is not that of a material mass, but that of the transport regime.

Conserving the parameters requires geometric adaptation. If a tube is compressed, its cross-section changes. If it is stretched, the internal distribution of rotation changes. If the axis curves, the relationship among twist, writhe, and the linking of vortex lines may be redistributed. All these transformations are admissible for as long as they do not destroy the invariant. Idealization makes it possible to analyze precisely these transformations without the immediate rupture of the system.

In the Unified Theory, this approach toward idealization prepares the subsequent process of axialization, understood not as simple geometric elongation, but as the progressive organization of transport along the direction of the axis, with reduced transverse deviations and increased flow coherence. The conceptual order must be preserved carefully. First, the flow approaches a regime in which its parameters can be conserved. Then conservation imposes successive geometric adaptations. Through these adaptations, transport can become increasingly ordered, stable, and axially oriented. Axialization does not precede idealization; it arises as a limiting effect of conservation within a coherent helical flow.

At this limit, the theory proposes the hypothesis that the transverse signature of fundamental flow may decrease. An increase in coherence or in η does not, however, demonstrate low detectability. This must be evaluated through defined observables — disturbance amplitude, dissipation, contrast, and detector response — and compared with the standard explanation of the system under study.

Thus, ideal flow is not the end of the analysis, but its rigorous beginning. It allows invariants to be formulated. Invariants make conservation understandable. Conservation explains geometric adaptation. And sustained, repeated geometric adaptation prepares axialization.

[D] Criterion for the ideal limit of conservation

A coherent vortex tube can be analyzed fundamentally only near the ideal regime, because there its parameters can be formulated as conserved quantities. Idealization is the working limit of conservation, and axialization arises subsequently as an effect of repeated geometric adaptation aimed at maintaining these parameters. Axialization must be understood as a progressive orientation of transport along the direction of the axis, not as a mere elongation of form.

5.3. Vorticity — the local signature of rotation

The first level in the description of a vortex is the local rotation of flow. In a fluid, not every displacement produces a vortex. A volume of fluid may undergo translational motion, flow uniformly, or be transported without neighboring elements rotating relative to one another. The vortex arises when local motion acquires rotational character. The quantity that describes this local rotation is vorticity.

Vorticity must not be confused with the visible rotation of the entire vortex. It is a local property of the velocity field. It shows where the flow tends to rotate, the direction in which this rotation is oriented, and how intense it is locally. If velocity describes the displacement of the fluid, vorticity describes how that displacement twists around a local direction.

This distinction is important because a coherent vortex is not defined solely by its global image. Within it are local distributions of rotation. Some regions may have intense vorticity, others weaker vorticity. The core, periphery, constitutive lines, and transition zones do not have the same kinematic structure. Vorticity makes it possible to read this internal differentiation.

In geometric language, vorticity indicates the local orientation of rotation. Wherever vorticity can be tracked continuously, vortex lines arise. These lines are not rigid material lines, but directions of the rotational field. They show how rotational motion is organized locally within the flow. If these lines gather into a coherent ensemble, a vortex tube can be defined.

Nevertheless, vorticity must not be treated as a simple global invariant. It may vary from one region to another, concentrate, stretch, redistribute, or dissipate. In a real vortex, vorticity is continually influenced by friction, shear, instabilities, and exchange with the environment. Even in a coherent tube, the local value of vorticity does not necessarily remain the same in every cross-section.

For this reason, in analyzing the vortex tube, vorticity is the beginning of the description, not its conclusion. It shows where local rotation exists and permits the internal structure to be defined, but it is not sufficient to describe the tube's global identity. For this, integral quantities are required, capable of linking local rotation to the continuity of the entire system.

In the Unified Theory, vorticity serves as the local signature of vortex organization. It marks the point at which flow ceases to be simple displacement and becomes oriented rotation. Through vorticity, motion acquires the capacity to form lines, filaments, bundles, and tubes. Without vorticity there is no vortex; but without the organization of vorticity there is no coherent tube.

Viewed in this way, vorticity is the first indication of a dynamic geometry. It is not yet the tube's memory, its topological identity, or its complete geometrodynamical state. It is, however, the local level from which all of these can emerge. The vortex begins where the flow has vorticity, and the tube begins where this vorticity acquires continuity.

[R] Proposition of local vorticity

Vorticity describes the local rotation of flow and represents the primary signature of vortex emergence. It is not, by itself, the global invariant of the tube, but it permits the definition of vortex lines and of the internal structure from which the coherent tube forms.

5.4. Vortex lines — the internal support of the tube

A vortex tube must not be imagined as a homogeneous column of fluid rotating simply around an axis. Within it lies a fine organization composed of local directions of rotation, filaments, branches, and subbranches. In fluid mechanics, these directions are described by vortex lines, namely lines tangent to vorticity at every point.

The vortex line is, in the first sense, a geometric instrument. It permits representation of the vorticity field. Just as a streamline shows the local direction of velocity, a vortex line shows the local direction of rotation. Through it, rotation ceases to be an isolated local fact and becomes a continuous trace within the flow.

In a coherent tube, vortex lines are not distributed randomly. They are organized around a global axis, participate in the same transport regime, and maintain kinematic compatibility with one another. They may lie closer to the core or closer to the periphery, may have different intensities, and may be deformed differently, but they cannot be completely independent if the tube remains coherent.

The Unified Theory extends the interpretation of these lines. In the classical description, the vortex line is a geometric construction associated with the vorticity field. Within the helical geometrodynamics framework, it may also be treated as a constituent filament of the tube, that is, as a smaller vortex integrated into a larger vortex. The global tube is formed from constituent lines, and these lines may in turn have sublines and internal structures.

This recursiveness is essential. A vortex tube is not merely a large form that contains rotation, but a system constructed from rotations organized across levels. The vortex line thus becomes the bridge between the local and global levels. Locally, it expresses the direction of vorticity. Globally, it participates in the construction of the tube.

This interpretation must be used precisely. Not every mathematical line drawn in a field automatically becomes a separate material vortex. A vortex line acquires constituent status only when it participates in a coherent flow regime, when it has continuity, orientation, and a role in global transport. In the absence of coherence, the lines may exist as local representations of rotation, but they do not form a stable system.

In a mature tube, the constituent lines behave as an internal architecture. They may twist around one another, form bundles, withstand deformations, and transfer geometric stresses. When a region of the tube is disturbed, the response does not belong only to the local area. Because the lines are part of the same ensemble, a change in one may require redistributions in the others. This idea will become important later, when the kinematic interdependence of the filaments will be analyzed.

For now, it is enough to establish that the vortex line is the tube's internal support. Without vortex lines, the tube would be only an external description of volumetric rotation. With vortex lines, the tube becomes an organized structure. It is no longer merely rotation within a volume, but a coherent ensemble of oriented filaments.

This organization explains why a tube can alter its geometry without immediately disintegrating. The constituent lines can absorb, redistribute, and compensate for deformations. They allow local adaptation of the tube without the immediate loss of global coherence. In this sense, vortex lines are not only indicators of rotation, but also elements of internal stability.

In the Unified Theory, this stability is not rigidity. The lines may be deformed, brought closer together, separated, twisted, or redistributed. Coherence arises when all these transformations remain compatible with the tube's global regime: axis, axial direction, chirality, IN, path, and OUT toward the attractor.

[R] Proposition of organization through vortex lines

A coherent vortex tube is internally supported by organized vortex lines. In fluid mechanics, they express the local direction of vorticity; in the Unified Theory, they will be treated as constituent filaments of the tube, that is, smaller vortices integrated into a global helical flow regime.

5.5. Circulation — the global intensity of rotation

If vorticity describes local rotation, circulation describes the rotation accumulated along a closed contour. It shifts the analysis from point to path, from a local quantity to a global measure. In a vortex, this transition is necessary because the structure cannot be understood solely through what occurs at a single point. A vortex is organization around a center, an axis, or a dynamic region, and this organization must be evaluated along contours that enclose the rotation.

Circulation may be understood as a measure of the flow's tendency to wrap around a region. If a contour surrounds the vortex core, the circulation associated with that contour indicates the global intensity of rotation. The more coherently oriented the motion along the contour, the more clearly circulation expresses the existence of a vortex structure.

This quantity has a fundamental role in fluid mechanics, especially in the ideal regime. In an ideal fluid, under certain conditions, circulation along a material contour may remain conserved. This means that organized rotation is not merely a transient image, but may possess kinematic persistence. The contour may deform together with the fluid, while the circulation associated with it may remain the same.

For a vortex tube, circulation is related to its intensity. It must not be confused with energy, force, or flow rate. Circulation does not state how much mass passes through the tube and does not directly express the system's energy consumption. It states how much organized rotation is accumulated around a region. For this reason, it is a kinematic quantity, not a simple material-transport quantity.

In a coherent tube, circulation provides a first criterion of identity. If the tube narrows, widens, or bends, circulation may remain a characteristic quantity of its regime. What is essential is not the shape of the cross-section, but the global rotation preserved around the core or around the ensemble of constituent lines.

This conservation is meaningful only near the ideal regime. In a strongly dissipative real flow, circulation may be altered by friction, viscosity, exchanges with the environment, or instabilities. In a coherent tube, however, losses do not immediately dominate the structure, and circulation may be treated as a stable quantity of the regime. It is precisely this stability that enables the transition from the observed vortex to the analyzed tube.

In the Unified Theory, circulation must be positioned between local vorticity and vorticity flux. Vorticity shows where local rotation exists. Circulation measures the global effect of this rotation along a contour. The vorticity flux will then link rotation to the tube's cross-section. The three quantities do not compete, but form successive levels of description.

Through circulation, the vortex begins to have a global intensity. It is no longer merely a region where the fluid rotates locally, but a structure in which rotation can be enclosed, measured, and tracked during deformation. This property makes the analysis of conservation possible.

Circulation also prepares the idea of compatibility between flows. Two vortices interact not only through spatial proximity, but also through the intensity, orientation, and direction of their circulation. However, this issue belongs to a later level of the theory, when the interaction kernels will be introduced. For now, circulation is treated as an internal quantity of the tube.

[R] Proposition of circulation in the vortex tube

Circulation measures the global rotation accumulated along a closed contour of the flow. In a coherent vortex tube, it expresses the kinematic intensity of rotation and may function, near the ideal regime, as a characteristic quantity of vortex identity.

5.6. Vorticity flux — continuity through the tube cross-section

To move from local rotation to the vortex tube, it is not enough to analyze vorticity at a point or circulation along a contour. The tube has a cross-section, axial extent, and continuity between successive sections. A quantity is therefore needed to describe how much organized vorticity crosses a surface associated with the tube. This quantity is the vorticity flux.

The vorticity flux may be understood as a measure of the organized rotation passing through a cross-section of the tube. If vorticity shows local rotation, and circulation shows the rotation accumulated along the contour, the vorticity flux shows the continuity of rotation through the surface. It is thus the quantity that links vortex lines to the vortex tube.

In a coherent tube, vortex lines do not appear and disappear arbitrarily between two neighboring sections. They must maintain sufficient continuity for the tube to be recognized as the same structure. If the tube cross-section changes, the local distribution of vorticity may change. Nevertheless, the total vorticity flux associated with the tube may remain characteristic of the regime.

This idea is central to conservation. A vortex tube may be compressed or expanded. If the cross-sectional area decreases, the distribution of vorticity may become more concentrated. If the area increases, rotation may spread over a wider domain. The geometry changes, but the integral quantity associated with the cross-section may remain stable in the ideal regime. Thus, the tube is conserved not by preserving the cross-section, but by preserving the flux that crosses it.

This property explains why geometry must be treated as an adaptive variable. If a system attempted to preserve a fixed form under all conditions, it would break when the environment changed. A coherent tube can avoid this rupture by adjusting its cross-section, local intensity, and distribution of vortex lines. Flux becomes what must be maintained; geometry becomes the means by which that maintenance is possible.

In ideal fluid mechanics, this idea is related to the persistence of vortex tubes. The tube is not a container with material walls, but a dynamic domain constructed from lines of vorticity. If these lines

remain organized and their flux through the cross-section is preserved, the tube maintains its identity even as its shape changes.

In the Unified Theory, the vorticity flux acquires an additional meaning. It becomes a bridge between internal structure and axial transport. The tube is not merely a sum of local rotations, but an organized conduction pathway. What crosses successive sections is not only fluid, but also the organization of rotation. In this sense, the vorticity flux describes the vortex continuity of the path.

This continuity is necessary for IN, the path, and OUT to belong to the same system. If the vorticity flux is lost or fragmented, the tube no longer conducts the same rotational structure. Flow may remain, turbulence may remain, and local vortices may appear, but the coherent tube loses its identity.

The vorticity flux prepares the analysis of helicity. Up to this point, the tube has been described through local rotation, lines, contours, and sections. But a mature tube is not merely continuity of vorticity. Its lines may link, twist, and writhe. To describe this internal architecture, a deeper invariant is needed, one capable of measuring not only the existence of rotation, but the way in which rotation is topologically organized. This invariant is helicity.

[R] Proposition of vorticity flux

The vorticity flux expresses the continuity of organized rotation through the cross-section of a vortex tube. In the ideal regime, the geometry of the cross-section may change, but the flux associated with the tube may remain a characteristic quantity of its vortex identity.

5.7. The vortex tube in the ideal regime — conservation and continuity

In the ideal regime, the vortex tube acquires its clearest physical meaning. It is no longer merely an observable region of rotation, but a flow structure that preserves its continuity through deformation. This property has made the vortex tube one of the most important conceptual objects in fluid mechanics.

In an ideal fluid, free of viscosity and analyzed in the absence of dominant dissipative processes, vortex lines cannot be treated as mere transient traces of motion. They are transported by the flow and remain connected to the fluid's internal organization. The tube formed by these lines may change shape, stretch, bend, or narrow, but it does not automatically lose its identity.

This idea must be understood precisely. The ideal regime does not mean that the tube remains geometrically unchanged. On the contrary, the tube may deform. What remains essential is not the instantaneous shape, but the continuity of the vortex lines and the conservation of the quantities associated with the flow. The shape may change precisely so that the structure can remain coherent.

In ideal fluid mechanics, a vortex tube does not end arbitrarily within the fluid. It must continue, close upon itself, or reach the boundary of the analyzed domain. This property expresses the fact that vorticity cannot appear and disappear in isolation at an interior point without a change in the fundamental conditions of the flow. The tube has continuity.

For the Unified Theory, this observation is of major importance. If a vortex tube is a geometrodynamical system, then it must have an identity that traverses the successive sections of the flow. IN, the path, and OUT are not separate regions, but functional parts of the same continuity. If this continuity breaks, the tube is no longer the same system.

A tube closed upon itself, of annular or toroidal type, represents a form of internal continuity. An open tube, oriented between IN and OUT, represents functional continuity between different regions of the system. In both cases, what matters is that organized rotation is not an isolated local event, but a coherent path of the flow.

This property allows the tube to be understood as a carrier of structural memory. If the vortex lines remain connected and their flux is preserved, the tube transports more than fluid. It transports an organization. This organization may be deformed, but it cannot be destroyed without breaking coherence or changing the flow regime.

However, a confusion must be avoided. Ideal conservation does not apply without limit to every real vortex. In real fluids, viscosity, turbulence, exchanges with the environment, and reconnections may alter the tube. The ideal regime is the limit in which the conservation principle can be formulated clearly. Reality approaches this limit only when dissipation does not dominate the structure.

In a coherent geometrodynamical tube, approximation to the ideal regime is not a mere abstraction. It expresses the system's tendency to reduce its losses and conserve its parameters. The better the structure succeeds in preserving its continuity, the more suitable it becomes for analysis through invariants.

Thus, the ideal vortex tube is the limiting model of conservation in a vortex flow. It shows what can remain constant when form changes. It does not yet tell us everything about the internal state of the flow, but it establishes the fundamental condition: a coherent helical flow must have continuity of vorticity, continuity of flux, and continuity of organization.

This continuity prepares the analysis of helicity. A tube is not merely a bundle of parallel vortex lines. Its lines may wrap, twist, link, and writhe. To describe this internal structure, an invariant is needed that measures not only the existence of rotation, but the way in which rotation is architected. This invariant is helicity.

[R] Proposition of the ideal continuity of the vortex tube

In the ideal regime, the vortex tube may alter its geometry without losing its structural continuity. Vortex lines do not end arbitrarily within the fluid, and the tube's identity is preserved through the continuity of vorticity, flux, and internal organization.

5.8. Helicity — the topological memory of flow

Vorticity, circulation, and vorticity flux describe fundamental levels of rotation. However, a mature vortex tube is not defined only by the fact that it rotates. It is also defined by the way its rotation is organized internally. Vortex lines may be simple or wrapped, parallel or twisted, straight or writhed, separate or linked together. To describe this internal architecture, helicity is required.

Helicity measures the degree of helical organization of the flow. It expresses the way velocity and vorticity correlate within a three-dimensional domain. Intuitively, helicity does not merely state that rotation exists, but shows how strongly the rotation is oriented, wrapped, and integrated into the flow structure.

Through helicity, the vortex tube acquires topological memory. This memory is neither psychological memory nor information stored in a technological sense. It is the memory of the flow's linking pattern. If the vortex lines are twisted, linked, or writhed in a particular way, this organization cannot be eliminated by a simple continuous deformation. To change it fundamentally, the system must undergo rupture, reconnection, or decoherence.

This property makes helicity much more profound than a simple measure of rotational intensity. Two tubes may have comparable circulations but different internal structures. One may have nearly parallel lines, while the other may have lines twisted and linked into a bundle. The difference between them is not merely quantitative, but structural. Helicity describes this difference.

In the ideal regime, helicity may be treated as the principal topological invariant of helical flow. This does not mean that it is the only possible invariant, nor that it completely describes the entire geometrodynamical state. It means that it captures one of the coherent tube's most important properties: the internal organization of its vortex lines.

For the Unified Theory, helicity is essential because it links rotation to identity. A vortex tube persists not only because the fluid continues to flow, but because its internal regime of organization is preserved. If this organization changes only through compatible deformations, the tube remains the same system. If the topological organization breaks, its identity changes.

Helicity makes it possible to understand how a tube can be deformed without being destroyed. The axis may bend, the cross-section may change, the core may narrow, and the periphery may writhe, yet the internal structure of the vortex lines may preserve the same topological memory. The visible geometry varies, but the flow's linking pattern remains recognizable.

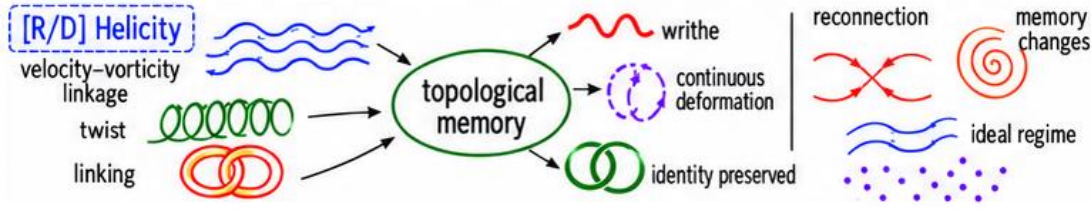
This idea differs from the conservation of a rigid form. A solid object preserves its identity by maintaining its contour and composition. A vortex tube preserves its identity by maintaining the internal relationships of the flow. *In its case, memory is fixed not in a material, but in a dynamic organization.*

In this sense, helicity is one of the best concepts for understanding how identity can exist in an open system. Matter enters and exits, geometry adapts, and the environment perturbs, yet the linking structure of the flow may persist. *This persistence is precisely topological memory.*

However, helicity must not be treated as absolute. In a real flow, viscosity, turbulence, and reconnections may alter or dissipate helicity. It must be treated as an invariant in the ideal regime or as a dominant structural quantity in a sufficiently coherent tube. This clarification is necessary to avoid turning a rigorous physical quantity into an unproven universal assertion.

In the Unified Theory, helicity prepares the transition from topology to geometrodynamics. It shows that the tube has structural memory, but it does not yet describe the complete kinematic state of the flow.

This will require additional constants specific to the helical model. Nevertheless, without helicity, it is impossible to understand how a flow can preserve identity during deformation.



[R/D] Fundamental principle — topological memory

Helicity describes the internal organization of vortex lines and functions, in the ideal regime, as the topological memory of the coherent tube. It measures not only rotation, but the way rotation is linked, twisted, and integrated into the flow structure.

5.9. L_k , T_w , and W_r — distinct components of topological memory

The topological memory of a vortex tube is not a simple property concentrated in a single geometric aspect. In the topological description, two levels must be distinguished: mutual linking L_k between distinct lines or tubes, and the self-linking of an individual tube, expressed by the sum of internal twist T_w and axial writhe W_r . For a closed, oriented tube, the geometric relation is $SL = T_w + W_r$, where SL is the self-linking number.

L_k , or the linking number, describes how two lines or filaments are linked together. If two filaments wrap around one another, their linking cannot be eliminated by a simple continuous deformation without cutting or reconnection. L_k expresses this topological connection between filaments.

T_w , or twist, describes how the internal structure of a filament rotates around its own axis. A filament is not merely a central line. It may have a cross-section, an internal orientation, and a distribution of vorticity. If this internal structure twists along the axis, the twist component appears.

W_r , or axial writhe, describes how the axis itself bends, meanders, or coils in space. A vortex tube need not be straight in order to be coherent. Its axis may be writhed, deflected, or curved. This deformation of the axial path contributes to the geometric memory of the ensemble.

L_k , T_w , and W_r must not be treated as quantities that are always positive. Their sign depends on the chosen orientation and geometric convention. They may be positive, negative, or zero, but they do not form an undifferentiated sum: T_w and W_r compose the self-linking of the same tube, whereas L_k describes mutual linking between distinct components.

This distinction is essential. In an individual tube, twist T_w may be converted into writhe W_r and vice versa, preserving the sum $SL = T_w + W_r$ as long as topology and orientation remain unchanged. Mutual linking L_k must not be confused with this internal conversion: it refers to the relationship between distinct tubes and changes topologically only through passages, cuts, or reconnections.

Redistribution between T_w and W_r explains the geometric adaptation of a tube: stretching may alter internal twist, while bending the axis may increase or decrease writhe. For distinct tubes, proximity or continuous deformation does not automatically change L_k ; the linking number remains invariant as long as the components do not intersect or reconnect. In the ideal regime, these transformations are compatible with conservation of total helicity.

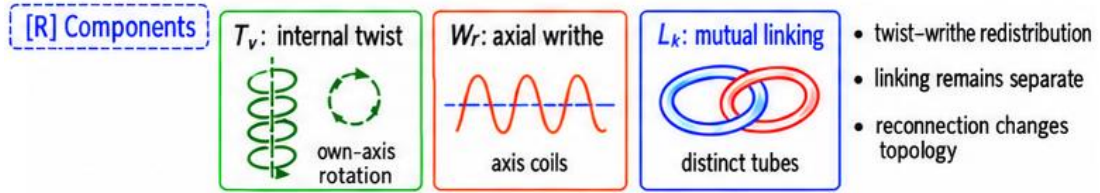
Therefore, T_w and W_r may be understood as two interconvertible reservoirs of a tube's self-helicity, whereas L_k preserves the memory of mutual linking between distinct tubes. All contribute to the total helicity of the ensemble, but through separate terms weighted by the circulations of the flows involved.

This property provides a more precise picture of stability. For an individual tube, topological stability allows compensations between T_w and W_r ; for a system of tubes, the mutual L_k contributions must be tracked separately. Identity is preserved not by freezing the geometry, but by conserving total helicity and the topological constraints corresponding to each level.

In the Unified Theory, this idea is compatible with the principle of geometric adaptation. The system does not defend a fixed form, but coherence. The axis, twist, and linking of vortex lines may change so that the tube can continue to transport its internal organization. Geometry is the variable; topological memory is the constraint.

This way of understanding prepares the transition toward branching and kinematic interdependence. If topological memory is distributed among internal components, then a local change in one vortex line

may require compensations in the others. *The tube is not a sum of independent filaments, but an ensemble in which memory is conserved through redistribution.*



[R] Proposition of topological components

For thin, oriented, and closed tubes, or for ribbons with a well-defined boundary, topological memory may be decomposed through T_w , W_r , and L_k . T_w and W_r contribute to self-linking, while L_k describes mutual linking between tubes. L_k remains invariant only under continuous deformations without intersection or reconnection; its relation to helicity requires explicit circulations, orientations, and boundary conditions. [10,11,37]

5.10. Geometric adaptation through helicity redistribution

A coherent vortex tube is continuously subjected to deformations. The environment may compress, stretch, deflect, twist, or perturb it laterally. In a rigid object, such stresses would produce mechanical tensions that could lead to cracking or rupture. In a vortex tube, the response is different: the system may alter the internal distribution of the flow in order to preserve coherence.

This capacity is expressed through the redistribution of helicity. If helicity describes the tube's topological memory, and this memory can be distributed among L_k , T_w , and W_r , then geometric deformation may be compensated by altering the ratio among these components. The tube adapts not by preserving its form, but by preserving the global relationship among its internal forms of organization.

Consider a tube that bends. Its axis is no longer straight, and the axial-writhe component changes. If the system remains coherent, this change may be compensated by changes in internal twist or in the linking between filaments. In this way, deformation of the axis does not immediately destroy topological memory, but is absorbed by the internal architecture.

Likewise, if the tube narrows, the vortex lines may move closer together, and the distribution of rotation within the cross-section changes. This change may affect the internal twist or the linking of filaments. If the adaptation is compatible, the tube preserves its identity. If adaptation is no longer possible, instabilities, fragmentation, or decoherence arise.

This logic must be formulated cautiously. It cannot be asserted without proof that the angular velocity increases by exactly the required amount or that the system perfectly compensates for every deformation. A rigorous formulation says something else: in a coherent regime close to the ideal, the tube may internally redistribute rotation and geometry in order to conserve the dominant structural quantities. Conservation is not automatic under all conditions; it is possible only as long as geometric adaptation remains compatible with the flow regime.

Through this adaptation, the vortex tube acquires dynamic stability. It is stable not because it remains motionless, but because it can transform external stresses into controlled internal changes. What would be destructive deformation for a rigid object may become reorganization for a coherent tube.

This property explains why geometry is an adaptive variable. The axis, cross-section, core, periphery, and constituent lines may change. But their change is meaningful only if it participates in conserving the tube's identity. Geometry that changes without preserving the invariants leads to disintegration. Geometry that changes in order to preserve the invariants becomes a mechanism of stability.

In the Unified Theory, this mechanism has general value. Coherent helical flow is not a fixed form imposed on the fluid, but an architecture that adjusts to maintain its fundamental parameters. Helicity shows the first level of this conservation: topological memory. The geometrodynamics constants to be introduced later will describe the kinematic level proper to this identity.

Geometric adaptation through the redistribution of helicity also prepares an understanding of branching. When the tube can no longer conserve its structure through simple deformation, it may redistribute its organization toward branches or secondary filaments. Part of its topological memory may be transferred into new structures, without the process being reduced to simple disappearance. The tube does not merely break; it may reconfigure its organization.

This distinction is important for the idea of decoherence. Decoherence must not be seen as the cancellation of motion, but as the loss of the old identity. When internal redistribution can no longer conserve the invariant, the system enters another regime. New vortices, new branches, or reorganized structures may arise, each with its own memory.

Therefore, geometric adaptation is not a secondary detail, but the mechanism by which the tube defends its coherence. *Helicity is conserved not despite the change in geometry, but through it.* The system changes its form in order to preserve its organization.

[R/H] Proposition of adaptation through topological redistribution

A coherent vortex tube may respond to deformations by redistributing helicity among linking, twist, and writhe. Geometry changes in order to conserve topological memory, and coherence persists as long as this redistribution remains possible.

5.11. Tube branching — transfer of helicity among roots, trunk, and branches

A coherent vortex tube does not always evolve as a single, simple, and undeviating structure. Under certain conditions, it may develop a number of roots, branches, secondary filaments, or substructures that detach from or functionally enter the main trunk without altering the process of stability. Branching is one of the forms through which helical flow redistributes its internal organization.

This branching must not be understood as the arbitrary appearance of independent vortices. If the branches originate from the same tube, they carry part of the organization of the parent tube. They have a common origin, are linked to the same prior flow regime, and may preserve a partially shared topological memory. In this sense, the branches are not merely separate fragments, but differentiated continuations of an initial vortex structure.

In the ideal or near-ideal regime, branching may be analyzed as a redistribution of helicity, either at the inlet, as roots, or at the outlet, as branches. Part of the trunk's topological memory may pass into the branches' own rotation. Another part may remain in the way these branches organize around the common axis or around a dominant transport direction. Thus, helicity does not simply disappear, but is allocated among new structures. The same applies in the inlet direction, that of the roots, through the composition of convergent helicities.

This idea allows a deeper interpretation of bifurcations, of branching. The interpretation follows a mirrored, reversed logic depending on the chosen direction, IN or OUT.

Consider the outlet, which follows a more intuitive line of reasoning. If a tube can no longer coherently conserve all geometric stress within a single structure, it may transfer part of this stress into branches. Branching thus becomes a geometrodynamical solution for adaptation. The system does not choose between perfect preservation and complete destruction; it may choose internal reorganization through the distribution of transport and topological memory.

The roots, trunk, and branches form an ensemble. The roots construct a unitary-oriented convergence, a concentrated transport zone. The trunk preserves the main orientation, the dominant axis, and the global transport regime. The branches take over part of the rotation, part of the flux, part of the geometric stress, and sometimes part of the conduction function toward secondary attractors or toward compatible regions for receiving transport. Depending on environmental conditions, the branches may remain dependent on the trunk, stabilize as secondary structures, or detach as new systems.

This detachment must not be confused with the total loss of continuity. There is a difference between coherent branching and incoherent fragmentation. In coherent branching, the secondary structures preserve a recognizable relationship with the initial tube. In incoherent fragmentation, the connection is lost, and the old vortex identity disintegrates. The former is adaptation; the latter is decoherence.

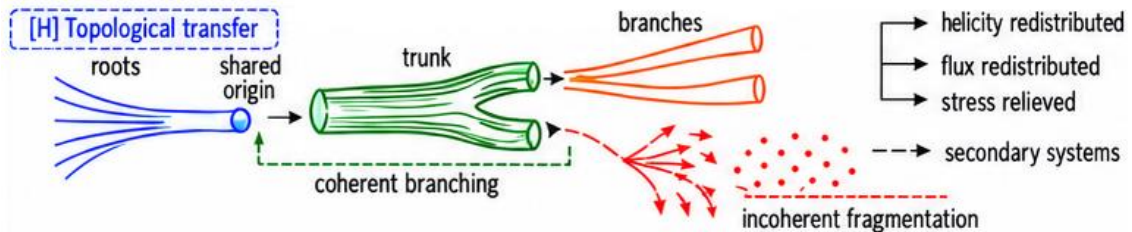
Branching may occur on several levels. A branch may contain subbranches, and these may in turn have constituent lines of their own. This recursiveness does not mean identical repetition to infinity, but organization across levels. Each level has its own scale, its own intensity, its own stability, and its own relationship to the ensemble of which it is part. The same applies to the roots.

In the Unified Theory, this picture is important because it allows the vortex tube to be treated as an evolutionary system. The tube is not merely a transport column; it is an architecture capable of altering its internal distribution. It can concentrate, conduct, redistribute, and generate secondary structures when conservation conditions require it.

Through branching, the first form of interdependence also appears among structures that have a common origin. The branches/OUT or roots/IN of a trunk are not completely independent because they

participated in the same initial topological memory. A change in one may require compensations in the other or in the main trunk. This interdependence must not yet be formulated as instantaneous action or a mysterious connection; it must be understood as kinematic and topological dependence among components of the same system.

This idea will become important in the later analysis of interactions and helical kinematic correlation. In this chapter, it remains at the level of conservation: branching is a form through which helicity, flux, and vortex organization may be redistributed between the trunk and the branches/roots.



[H] Proposition of branching through topological transfer

A coherent vortex tube might develop branches or roots through the redistribution of flow, helicity, and internal organization. Branches or roots belonging to the same trunk would not be absolutely independent, but would preserve a relationship of origin and a compatibility that must be defined through balances and observables.

5.12. Reconnection, decoherence, and change of identity

Topological conservation of the vortex tube is valid only as long as the structure can be deformed without rupture or fusion. In the ideal regime, the tube may alter its geometry through stretching, bending, narrowing, or twisting, but its vortex lines do not reconnect arbitrarily. Topological identity is preserved precisely because the structure remains continuous.

However, every natural system has limits. If deformations become too great, if the environment imposes incompatible stresses, or if the vortex lines reach a configuration in which adaptation can no longer conserve the parameters, a change of regime occurs. At that point, the tube can no longer remain the same system through simple deformation. It enters the domain of decoherence.

Reconnection is one of the mechanisms through which topological identity may change. It does not belong to the strictly ideal regime, but appears when ideality is locally exceeded, for example through viscosity, diffusion, or other non-ideal effects. The connectivity of vortex lines changes, and the previous topological memory is no longer the same. Global helicity may be approximately conserved in certain regimes, but it may also be redistributed or dissipated; the behavior is not universal. [10,11,37]

This change must be treated precisely. Reconnection does not mean the disappearance of motion. It does not mean that the fluid, field, or medium ceases to exist. It means that the old vortex organization can no longer be maintained. The former tube loses its identity, and the flow reorganizes into new structures.

Decoherence is thus the loss of the system's identity, not the cancellation of the process. A tube may lose its coherence, but vorticity may continue to exist in local forms. New vortices, unstable branches, secondary structures, or disorganized flows may arise. What disappears is the coherence of the old ensemble.

This distinction is fundamental to the Unified Theory. If the system is defined by conserved parameters, then a change in these parameters beyond a certain limit is not a simple variation. It is a change of identity. A tube that alters its geometry but preserves its invariants remains the same system. A tube that can no longer conserve these invariants enters another state.

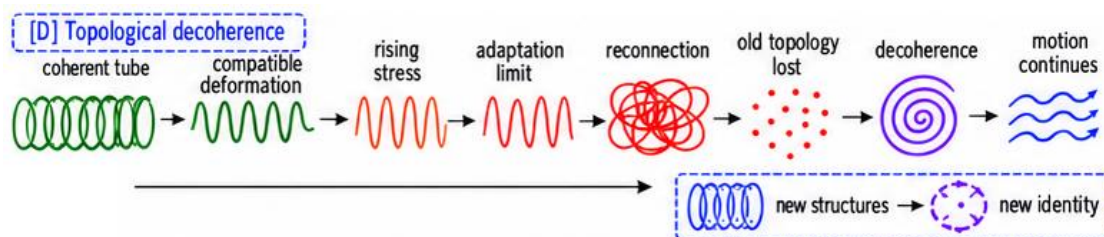
In this sense, decoherence must not be regarded as an absolute failure, but as a moment of transition. The old system can no longer withstand the conditions imposed by the environment, but the flow seeks a possible new organization. If a new coherence appears, a new vortex identity also appears. It will have its own characteristic values, its own lines, its own helicity, and its own transport regime.

This perspective explains why stability cannot be confused with permanence. No tube is stable because it does not change. Stability means the capacity to change without losing what must be conserved. When this capacity is exceeded, stability ends and reconfiguration begins.

Reconnection marks precisely the boundary between conservative deformation and identity transformation. Up to reconnection, the tube may adapt its geometry. After reconnection, the old

topology is no longer the same. At this point, the initial helicity may be redistributed, partially dissipated, or reorganized into new structures.

In the Unified Theory, this process prepares the idea of the geometrodynamic cycle: emergence, conservation, adaptation, geometric stress, decoherence, and reconfiguration. The vortex tube is not merely a structure, but a structure with a dynamic life. It has genesis, duration, a limit, and the possibility of transformation.



[D] Criterion of topological decoherence

A vortex tube preserves its identity as long as its deformations can conserve connectivity and the relevant quantities within the stated domain of validity. When geometric adaptation can no longer maintain them, the system loses its coherence, and the flow may reconfigure into structures with a new identity.

5.13. Invariant, memory, and information

Invariants are not merely calculation tools. In a geometrodynamic system, they express what the system preserves during transformation. For this reason, the invariant may be understood as the support of structural memory. It does not contain every detail of the flow, but establishes what is not lost when geometry changes. *If it is not lost, then it is retained, similarly to memory.*

This idea requires a clear distinction between an invariant and the value of the invariant. The invariant defines the type of quantity that may be conserved. The value of the invariant defines the particular state of the system. Two tubes may conserve the same type of quantity but have different values. In that case, they belong to the same general class of description, but do not have the same particular identity.

For example, helicity as a quantity expresses the possibility of describing the topological memory of the flow. The value of helicity expresses a particular organization of the analyzed tube. If the value is preserved during deformation, the tube maintains its topological identity. If the value changes through reconnection or decoherence, the system passes into another state.

Therefore, the invariant is the support of memory, and the value of the invariant is the particular structural information. This formulation must be understood physically, not metaphorically. Information here is not an external message introduced into the system, but the specific difference by which one system is distinguished from another. The conserved value makes it possible to recognize continuity.

This distinction is important for the entire framework of the Unified Theory. A system is defined not only by the fact that it has invariants, but by the values they take. If two tubes have the same visible geometry but different invariant values, they are not the same system. If a tube changes its visible geometry but preserves the relevant values, it may remain the same system.

Structural memory is not the preservation of form, but the preservation of the relevant difference. Form may vary. The core may move, the axis may writhe, the cross-section may change, and the branches may be redistributed. *If the invariant values are maintained, the system preserves its structural information.*

This idea permits a clearer definition of geometrodynamic identity. Identity is neither merely material continuity nor merely visual similarity. Identity is the conservation of the system's relevant values during transformation. For the vortex tube, this identity begins with circulation, vorticity flux, and helicity, but it does not end there.

In the Unified Theory, other quantities will also be needed, capable of describing not only topological memory but also the kinematic regime of helical transport. These quantities must state how flow is conserved as an internal state, how transport efficiency is preserved, and how compatibility with other flows is established. Here arises the need for proper geometrodynamic constants.

However, before these constants, the general principle must be fixed: every physical constant of a coherent system has a dual role. As a type of quantity, it indicates what may be conserved. As a value,

it indicates the system's particular information. This dual function turns the invariant into a carrier of memory.

Through this interpretation, memory is not added to the flow later. It arises from conservation. A system that conserves nothing cannot have identity; it has no memory. A system that conserves relevant quantities can be recognized as the same through successive transformations. Conservation thus becomes the physical basis of memory.

As an operational analogy, a speed of 50 km/h maintained by a regulator is not an invariant of the vehicle, but a target value stored and controlled over an interval. Similarly, the theory's hypothesis is that a coherent tube may preserve certain state values within tolerance limits over the analyzed interval. The analogy explains the difference between the type of parameter and its value, without proving the vortex constants.

[H] Proposition of memory through invariant value

The invariant defines the type of conserved quantity, while the value of the invariant defines the particular structural information of the system. A vortex tube preserves its identity when the relevant values of its invariants are conserved during geometric adaptation.

5.14. The limit of topology — why helicity is not sufficient

Helicity is a profound invariant, but by itself it cannot describe the entire state of a helical flow. It shows how vortex lines are linked, twisted, and writhed, but it does not exhaust every aspect of a geometrodynamical tube. A transport system is defined not only by topology, but also by its kinematic regime, orientation, flow rate, efficiency, IN–path–OUT relationship toward the attractor, and compatibility with the environment.

This limitation must be stated clearly. If helicity were sufficient, then two tubes with the same topological memory would be completely equivalent. But this is not necessarily so. Two tubes may have the same linking class or comparable helicity values, yet have different intensities, different axial directions, different chiralities, different cross-sections, different flow rates, or different relationships with the attractor.

Topology describes the deep form of connectivity. Kinematics describes the concrete manner in which flow unfolds. A vortex tube is simultaneously a topological structure and a kinematic process. If we analyze only topology, we risk preserving the skeleton while losing the flow. If we analyze only local kinematics, we risk seeing the motion while losing structural memory. Both levels are necessary.

Helicity shows how rotation is organized internally. By itself, it does not state how efficient transport is, how the flow rate changes, how the regime between IN, the path, and OUT toward the attractor is conserved, what type of coupling the tube may have with other flows, or what conditions must be met for coherent interaction. These questions go beyond topology and require proper geometrodynamical invariants.

Moreover, helicity alone does not establish the functional direction of the tube. A tube has an axis, an axial direction, and chirality. Chirality is correctly defined only with respect to the chosen axial direction. Topology can describe wrapping, but the functional orientation of transport requires an additional level of description. In the Unified Theory, this level is essential because the tube is not merely form, but transport toward the attractor.

Topology also does not fully describe the relationship with the exterior. A tube may have a stable internal structure yet be incompatible with the environment it enters. It may encounter another tube with a different orientation, different chirality, or incompatible coupling parameters. In that case, the issue is no longer only its own helicity, but the interaction between systems.

This limitation does not diminish the importance of helicity. On the contrary, it establishes its proper place. Helicity is the principal topological memory of the coherent tube. But topological memory is not the entire geometrodynamical identity. Complete identity must also include the kinematic state of the flow, the conservation of transport parameters, and the rules of compatibility with other systems.

This distinction prepares the transition toward the Preda constants. If vorticity, circulation, vorticity flux, and helicity form the physical and topological foundation, then the next step is to define quantities that describe helical flow as a system in its own right. These quantities must not duplicate helicity, but complement what topology cannot state.

In this way, Chapter 5 establishes the natural limit of the established invariants. They are necessary, but not sufficient. Without them, the theory has no physical foundation. With them alone, the theory

cannot fully describe the geometrodynamic flow. A transition from topological invariant to geometrodynamic invariant is required.

[D] Criterion of the topological limit

Helicity describes the topological memory of the vortex tube, but it does not exhaust the identity of helical flow. A complete description of the system also requires proper kinematic invariants capable of expressing transport, orientation, efficiency, and interaction compatibility.

5.15. Toward the Preda constants — from topological invariant to geometrodynamic invariant

The invariants analyzed thus far belong to the established foundation of vortex flows. Vorticity describes local rotation. Circulation describes global rotation along a contour. The vorticity flux describes continuity through the cross-section. Helicity describes the topological memory of internal organization. Together, these quantities make it possible to understand the vortex tube as a coherent structure.

However, the Unified Theory requires an additional step. The vortex tube is analyzed not only as an object of fluid mechanics, but as a helical geometrodynamic system. This means that one must describe not only how vortex lines are linked, but also how the flow conserves its internal transport state.

A geometrodynamic tube has IN, a path, and OUT toward the attractor. It receives, organizes, and conducts. It has an axis, axial direction, chirality, constituent lines, and a dynamic boundary. It adapts geometrically in order to conserve coherence. These elements are not fully described by helicity. *They require an internal state equation for helical flow.*

The Preda constants must be introduced precisely at this point in the construction. They are not presented as replacements for established invariants, but as an additional level of description. Vorticity, circulation, flux, and helicity show the physical foundation of the vortex. The proper geometrodynamic constants will describe the kinematic identity of the tube as a transport system.

This transition must be made rigorously. A proper constant cannot be introduced merely by assertion. It must have a clear role: what quantity it describes, under what conditions it is conserved, how geometry changes to preserve it, and what happens when it can no longer be conserved. Only in this way do the Preda constants become theoretical tools rather than mere names.

Within the logic of this work, the proper constants must express the internal state of helical flow. They must describe variation in flow rate, flow form, transport efficiency, and the system's kinematic compatibility. In addition, they must make it possible to distinguish between tubes that may appear topologically similar but have different geometrodynamic behaviors.

Here the problem of coupling also arises. A tube does not exist only within itself, but in an environment where it may interact with other tubes. Spatial proximity is not sufficient: direction, chirality, axis orientation, phase, kinematic regime, and the independent components of the state must be compared. The number α will be introduced later as a hypothetical scalar filter; by itself it does not decide coupling and does not yet have the status of an interaction constant.

Therefore, there is a natural transition. We now establish what conservation means for a vortex tube in the physical and topological sense. The next chapter establishes what conservation means for helical flow in the proper geometrodynamic sense.

This transition is necessary in order to avoid two errors. The first would be to reduce the Unified Theory to classical fluid mechanics. The second would be to detach it completely from fluid physics and introduce constants without foundation. *The correct path lies between them: it begins with the established invariants, then extends the analysis toward the invariants proper to the helical model.*

The Preda constants must therefore be presented as a geometrodynamic extension of the conservation problem. They do not negate helicity, but complement it. They do not eliminate vorticity, circulation, and flux, but integrate them into a broader framework of axial transport, geometric adaptation, and interaction between systems.

[H] Proposition of the transition to the geometrodynamic invariant

Topological invariants describe the structural memory of the vortex tube, but coherent helical flow also requires proper kinematic invariants. The Preda constants will be introduced as an additional level of conservation intended to describe the internal state, transport efficiency, and coupling compatibility.

5.16. Idealization, conservation, and the onset of axialization

The analysis of invariants naturally leads to the problem of axialization. However, the conceptual order must be preserved. Axialization is not the starting point of coherent flow, but the limiting effect of an evolution in which the system approaches the ideal regime, conserves its parameters, and repeatedly adapts its geometry.

First comes approximation to idealization. A helical flow becomes amenable to fundamental analysis when losses and disorder do not immediately destroy the structure. In this limit, the parameters may be formulated as conserved quantities. Without this approximation to the ideal regime, the identity of a vortex tube over long durations cannot be discussed rigorously.

Then comes conservation. The system tends to preserve the quantities that define its identity: continuity of vorticity, circulation, vorticity flux, topological memory, and later the proper geometrodynamical constants. Conservation is not passive. It is achieved not through immobility, but through a change of form.

Geometric adaptation follows from conservation. The tube may bend, narrow, thicken, twist, branch, or reorganize locally in order to preserve its parameters. Geometry becomes the instrument of conservation. If adaptation succeeds, the system remains coherent. If adaptation is no longer possible, decoherence occurs.

Axialization appears after these stages. It represents the evolutionary effect of a flow that has sufficiently reduced its losses, stabilized its parameters, and oriented its transport ever more efficiently along the axis. As geometric adaptations eliminate unnecessary deviations, transverse components become progressively smaller, and the flow becomes increasingly organized axially.

Axialization does not mean the disappearance of helical geometry. In the model, the ratio η increases and transverse dispersion decreases, while rotation and chirality may remain present. Stability, dissipation, and response to perturbation are additional observables and do not follow solely from the kinematic definition.

From this, only a working hypothesis is formulated: axialized flows might have a reduced transverse signature. The hypothesis requires a detection model, an instrumental threshold, and a differential prediction; capture, orientation, or attraction cannot be attributed to axialization without excluding standard mechanisms.

This idea has the status of a geometrodynamical hypothesis. The theory proposes testing a correlation between increasing η , decreasing transverse dispersion, and a change in a defined instrumental signature. The absence of direct observation does not confirm the hypothesis; quantitative effects that differ from the standard prediction are required.

Axialization prepares the following chapters. To describe it rigorously, helicity and topology must be supplemented by state quantities, η , and observable elements of dispersion. Detectability remains a separate experimental problem requiring a model of signal, noise, and instrumental threshold.

In this section, axialization remains the hypothetical conclusion of the conservation problem. If state quantities are preserved through successive adaptations, the flow may evolve toward more axially oriented transport, with increased η and reduced transverse dispersion. Local visibility does not follow from this definition.

[H] Proposition of idealization, conservation, and axialization

A coherent helical flow may approach an idealized regime in which its parameters are preserved. Under the model's hypothesis, repeated adaptation may lead to axialization: η increases, while transverse dispersion and the rate of reconfigurations decrease. Detectability must be analyzed separately.

5.17. Conclusion — from topological memory to the geometrodynamical state

The vortex tube cannot be understood solely through its visible form. Form changes, matter is replaced, the cross-section adapts, the axis bends, the constituent lines are redistributed, and branches may appear or disappear. *What gives continuity to the system is not its instantaneous geometry, but the conservation of structural quantities.*

Vorticity shows local rotation. Circulation expresses global rotation along a contour. The vorticity flux describes the continuity of rotation through the tube cross-section. Helicity introduces the

topological memory of the ensemble through the linking, twist, and writhe of vortex lines. Together, these quantities enable the transition from the image of the vortex to its dynamic identity.

In the ideal or near-ideal regime, the vortex tube may conserve these quantities by adapting its geometry. This adaptation is not an accident, but the mechanism by which the system defends its coherence. Geometry becomes variable, while the invariant becomes the condition of continuity. When adaptation can no longer conserve the relevant quantities, the old identity is lost, and the system enters decoherence and reconfiguration.

However, topology does not describe the entire flow. It shows structural memory, but does not exhaust the kinematic state of the tube, transport efficiency, variation in flow rate, coupling compatibility, and the complete relationship between IN, the path, and OUT toward the attractor. For this reason, the Unified Theory must move further, from the topological invariants of the vortex tube to the proper geometrodynamical invariants of helical flow.

This transition opens the need for the Preda constants. They do not replace vorticity, circulation, flux, or helicity, but complement them. If topological invariants describe the memory of the flow form, the geometrodynamical constants must describe the internal state of helical transport. Through them, the vortex tube is no longer merely a conserved structure, but a flow system with its own kinematic identity.

The next chapter will develop this level of description: the Preda constants and the internal state relation of helical flow.

PART II · FORMALISM, MEMORY, AND PROPAGATION

6. The Fundamental Preda Constants and the Internal State Relation of Helical Flow

6.1. Methodological status of the Preda constants

The preceding chapter showed that the identity of the vortex tube resides not in its instantaneous form, but in the conservation of structural quantities during adaptation. The formulation of its internal state relation begins here.

In fluid mechanics, these quantities appear in established forms: vorticity, circulation, vorticity flux, and helicity. Vorticity describes local rotation. Circulation expresses the rotation accumulated along a contour. The vorticity flux describes continuity through the tube cross-section. Helicity expresses the topological memory of internal organization. Together, these quantities enable the transition from the image of the vortex to its dynamic structure.

However, these quantities are not sufficient for the purpose of the Unified Theory. They describe rotation, continuity, and topological memory, but they do not completely describe the internal state of helical transport. A coherent vortex tube is not merely a topological structure. It is an oriented flow system, with IN, a path and OUT toward the attractor, with an axis, axial direction, chirality, constituent lines, geometric adaptation, and the possibility of coupling with other flows.

For this reason, an additional level of description is necessary. This level is introduced through the Preda constants. They do not replace the known invariants of fluid mechanics, but complement them. If topological invariants describe the tube's structural memory, the Preda constants must describe the kinematic identity of coherent helical flow.

In what follows, C_c , C_f , and C_e are operationally defined as the Preda descriptors. When their conditional conservation is invoked, the volume refers to them as the postulated 'Preda constants.' The designation is internal to the Unified Theory and does not present them as established constants of physics.

This clarification is essential. The Preda constants must not be presented as quantities already established in current physics, nor as mere convenient notations. They are introduced in this work as proposed geometrodynamical invariants needed to describe a particular type of system: coherent helical flow. In this manuscript, "constant" denotes conditional conservation within a declared coherent regime;

outside that regime, C_c , C_f , and C_e are reported as state descriptors whose constancy remains to be tested.

Therefore, the formulas defining the Preda descriptors have definitional status, while their conditional conservation has the status of a geometrodynamical postulate. The postulate becomes scientifically useful only through verifiable consequences concerning geometric adaptation, coherence, loss of identity, reconfiguration, and compatibility between flows.

This approach is compatible with the general way physics treats invariants. In many theories, a conserved quantity is introduced not as a formal ornament, but as the expression of a constraint, a symmetry, or a state condition. Noether's theorem shows, within an established mathematical framework, the profound connection between symmetries and conservation laws. The Unified Theory does not derive the Preda constants directly from Noether's theorem, but retains the same methodological requirement: a constant must express a real constraint of the system.

Similarly, fluid physics and the physics of quantum systems provide examples in which vortex structures have conserved or quantized quantities. In ideal fluids, the circulation and topology of vortex tubes may persist. In superfluids, quantum vortices show that organized rotation can be linked to discrete circulation values. These examples do not prove the Preda constants, but they show that the idea of a vortex identity defined through state quantities is not foreign to known physics.

The methodological order is therefore strict. First, the analyzed system is defined. Then the vortex tube is identified as a transport structure. Next, the established invariants of the flow are analyzed. Their limit is then shown. Only at this point are the Preda constants introduced as proper quantities intended to describe the internal state of helical flow.

This order separates theory from mere intuition. Intuition may observe a pattern, suggest a relationship, and indicate a direction for research. But intuition is not sufficient for constructing a theory. To become part of a scientific framework, intuition is transformed into definition, postulate, consequence, and verification criterion.

In this chapter, the Preda descriptors will be defined, delimited, linked to the variables of helical flow, and used to formulate the internal state relation of the coherent vortex tube. Their proposed conservation will then be stated separately as a testable hypothesis. Definition of a quantity does not demonstrate its invariance.

In this form, the theory becomes controllable. If a vortex tube changes its geometry but preserves its constants, then it preserves its kinematic identity. If the geometry can no longer adapt to conserve the constants, the system loses its former identity and enters decoherence. If a new coherence appears, a new set of constants also appears.

Thus, the Preda constants are introduced not to embellish the description of the vortex tube, but to answer a precise problem: how can the identity of a helical flow be defined when its form changes continuously?

[D/H] Status of the Preda descriptors and candidate invariants

C_c , C_f , and C_e are operationally defined as the Preda descriptors and proposed as candidate geometrodynamical invariants of coherent helical flow. Their definitions do not establish their conservation. Conditional invariance within a declared coherent regime is the testable hypothesis of the model.

6.2. From topological invariant to geometrodynamical invariant

A topological invariant describes what remains unchanged in the connectivity of a structure when it is deformed without rupture or reconnection. In the case of the vortex tube, helicity and its associated components describe how vortex lines are linked, twisted, and writhed. This level is fundamental because it shows that a coherent tube can preserve structural memory during deformation.

This framework is close to the classical results of Helmholtz and Kelvin concerning vortex tubes in ideal fluids. In that regime, vortex lines are transported by the flow, and circulation may remain conserved under restrictive conditions. Later, studies of topological hydrodynamics showed that helicity may function as a measure of the linking and twisting of vorticity lines. Through these results, fluid mechanics already provides a language of structural persistence.

However, topology does not describe the entire flow. It states how the lines are linked, but does not fully state how transport occurs. It does not sufficiently describe variation in flow rate, the ratio between

axial and tangential motion, the efficiency of the transport regime, the functional direction of the flow, or the kinematic compatibility between two adjacent tubes.

This limitation is not a weakness of topology. It is merely the boundary of its domain. Topology answers the question: how is the structure linked? Geometrodynamics must answer an additional question: how does the structure flow so that it remains the same during transformation?

For a coherent helical flow, the two questions do not exclude one another. On the contrary, they complement each other. A vortex tube needs topological memory in order to preserve its internal structure, but it also needs kinematic identity in order to preserve its transport regime. If it preserves only the topology but loses its flow regime, the system no longer functions as the same geometrodynamical tube. If it preserves local motion but loses its structural memory, the flow fragments or reconfigures.

The geometrodynamical invariant must therefore describe the relationship between geometry and motion. It refers neither solely to the tube's form nor solely to local velocities, but to those combinations of quantities that remain stable when form and velocities change together. In such a system, conservation does not mean preserving each variable separately, but preserving a relationship among variables.

This is the essential difference. The tube radius may vary. The cross-section may vary. The axial velocity may vary. The tangential velocity may vary. The helical pitch may vary. But if these variations are correlated so that certain fundamental relationships are preserved, the system conserves its kinematic identity.

The Preda constants must be understood precisely as such conserved relationships. They are not isolated variables, but conditions of coherence. They express the way helical flow adjusts its geometry so as not to lose its internal state. For this reason, they belong to the geometrodynamical level: a level at which geometry and dynamics can no longer be separated.

From this perspective, geometry is not the backdrop of flow, and velocity is not a quantity independent of geometry. A smaller radius changes the conditions of rotation. A larger cross-section changes the flow rate. A greater axial velocity changes the helical pitch. A different tangential velocity changes the winding. Every geometric change requires a kinematic change, and every kinematic change is expressed geometrically.

An established example of geometric coherence in flows is Beltrami flow, in which velocity and vorticity are aligned. *Such a state does not prove the Preda constants, but it shows that fluid mechanics contains regimes in which field geometry and the dynamics of motion may become deeply correlated. The Unified Theory proceeds in the same general direction, but seeks the conserved relationships specific to coherent helical flow.*

The geometrodynamical invariant is precisely the quantity that remains stable in this co-evolution. It does not state that the system does not change, but that change is controlled. It does not state that the tube has a fixed form, but that the transformation of form obeys a conserved internal relationship.

In the Unified Theory, this idea makes it possible to define helical flow as a system with its own identity. The tube is neither merely a rotating volume nor merely a bundle of vortex lines. It is a state of transport. And a state of transport must be described through quantities that can remain constant while transport adapts.

From this follows the transition from topological invariant to geometrodynamical invariant. Topology preserves structural memory. Geometrodynamics preserves kinematic identity. The former shows how the tube is linked. The latter shows how the same flow persists during transformation.

[H] Fundamental principle — the geometrodynamical invariant

A geometrodynamical invariant conserves neither a rigid geometric form nor any isolated local variable, but a stable relationship between geometry and motion. In coherent helical flow, the system's identity is preserved by conserving these relationships, while the individual variables may adapt.

6.3. Domain of validity of the Preda constants

The Preda constants do not apply to every fluid motion or to every local turbulence. They are defined only for coherent helical flows, that is, for systems in which rotation, transport, and geometry form a recognizable ensemble sufficiently stable to be tracked over time. Although they may theoretically apply equally well to any very short-lived vortex tube, such tubes cannot be detected or tracked.

This delimitation is necessary. In a completely disordered flow, local variables change rapidly, vortex lines form and disintegrate, and the structure does not preserve sufficient identity for one to speak of proper constants. Local rotations, fluctuations, and vorticity may exist, but a coherent vortex tube

does not necessarily exist. If one does, the very short time between its emergence and disintegration does not permit detection.

For a flow to enter the domain of the Preda constants, a recognizable axis must first exist. This axis need not be perfectly straight or fixed in space. It may be curved, writhed, or adapted by the environment. What matters is that it functions as the dominant direction organizing transport.

Second, an axial direction must exist. The flow must not be merely a locally closed rotation, but must have a functional transport direction. This axial direction makes it possible to distinguish among inlet, path, and functional outlet toward the attractor.

Third, chirality must exist. A helical flow is defined not only by the fact that it advances along an axis, but also by the way it wraps around that axis. Chirality cannot be established without reference to the axial direction. Therefore, axial direction and chirality must be treated together.

Fourth, a functional IN–path–OUT relationship must exist. IN represents the region where the flow is captured, loaded, or converges. The path represents the region of coherent transport. OUT represents the conduction of the flow toward the attractor or toward compatible regions for receiving transport. Without this architecture, the tube cannot be treated as a complete geometrodynamical system.

Fifth, compatible constituent lines must exist. The tube is not a homogeneous column, but a structure formed from vortex lines or filaments that participate in the same global regime. These lines may undergo local deformations, but they must remain compatible with the axis, direction, chirality, and overall transport.

Sixth, the system must be near the ideal regime. This does not mean the absolute absence of losses, but that dissipation, turbulence, and reconnections do not immediately destroy coherence. *The Preda constants are state quantities of coherent flow, not of complete disorder.*

Seventh, an interval of persistence must exist. A structure that appears and disappears instantaneously may be interesting as a fluctuation, but it cannot be characterized by its own set of constants. To speak of kinematic identity, the system must be recognizable as the same system over an interval of transformation.

These conditions establish the domain of validity of the Preda constants. They apply to the coherent vortex tube, not to fluid in general; to organized helical flow, not to indiscriminate turbulence; to a system with oriented transport, not to local rotation without continuity.

This delimitation protects the theory from uncontrolled extension. Not every spiral is automatically a coherent helical flow. Not every local rotation has Preda constants. Not every structure visually resembling a vortex must be included in the same regime. It must first be verified whether there is a system, axis, direction, chirality, transport, coherence, and persistence.

Within this framework, the Preda constants may be formulated as quantities of the internal state. They do not describe the external environment as a whole, but the flow that has succeeded in becoming functionally delimited within the environment. They appear only where transport has become sufficiently coherent to possess identity.

[D] Criterion for the domain of validity

The Preda constants are valid only for coherent helical flows defined by an axis, axial direction, chirality, constituent lines, an IN–path–OUT architecture toward the attractor, geometric adaptation, and persistence. They do not describe every turbulence, but those flow regimes that can conserve a kinematic identity during transformation.

6.4. Minimal variables of helical flow

To define the Preda constants, a minimal set of variables must be established. A coherent helical flow cannot be described solely through position, velocity, or local rotation. It combines axial displacement with tangential motion, cross-section with helical pitch, flow rate with rotation period, and geometry with transport.

Consider a coherent vortex tube analyzed locally over an interval in which its axis can be approximated as the dominant transport direction. This approximation does not require the tube to be perfectly straight. The axis may be curved or writhed, but over a sufficiently small segment a local axial reference frame can be defined.

The first variable is the local radius of the flow, denoted by:

$$r$$

This must not be understood as the radius of a material wall, because the vortex tube has no rigid walls. The radius describes the effective transverse extent of the domain within which the flow remains coherent.

The idealized cross-section of the tube may be written as:

$$A = \pi r^2$$

This formulation is a local circular idealization. In a real tube, the cross-section may be elliptical, deformed, or variable, but the circular form represents the first approximation needed to define the fundamental relationships.

The axial velocity is denoted by:

$$v_a$$

It describes the transport component along the tube's axis. This component is responsible for moving the flow between IN, the path, and OUT toward the attractor.

The tangential velocity is denoted by:

$$v_t$$

It describes the rotational component of the flow around the axis. Without this component there is no helical character, only axial transport.

The local angular velocity is:

$$\omega = \frac{v_t}{r}$$

This relation expresses the elementary connection between transverse rotation and local radius. If the radius changes, the same tangential velocity produces a different angular velocity. It already follows from this that geometry and dynamics cannot be separated.

The volumetric flow rate is:

$$Q = A v_a$$

or, in the circular approximation:

$$Q = \pi r^2 v_a$$

Flow rate describes the volume of medium transported through a cross-section per unit time. In a coherent flow, flow rate is not merely a quantitative measure, but part of the tube's internal state.

The period of one rotation is:

$$T = \frac{2\pi}{\omega}$$

and the rotation frequency is:

$$f = \frac{1}{T} = \frac{\omega}{2\pi}$$

The helical pitch is the axial distance traveled during one complete rotation:

$$p = v_a T$$

Substituting the period gives:

$$p = \frac{2\pi v_a}{\omega}$$

and using the relation $\omega = \frac{v_t}{r}$, it follows:

$$p = \frac{2\pi r v_a}{v_t}$$

This relation is fundamental to helical flow. It shows that the helical pitch is not a simple geometric dimension, but the result of the ratio between axial transport and tangential rotation.

The internal helical ratio may be defined by:

$$\eta = \frac{p}{2\pi r}$$

By substitution, it follows:

$$\eta = \frac{v_a}{v_t}$$

This quantity expresses the proportion between axial advance and transverse winding. If η is small, the flow is more tightly wound. If η is large, the flow is more axialized.

In addition to these continuous variables, helical flow also has two discrete characteristics. The first is the axial direction, denoted by:

$$S$$

This indicates the functional direction of transport along the axis. The second is chirality, denoted by:

$$\chi$$

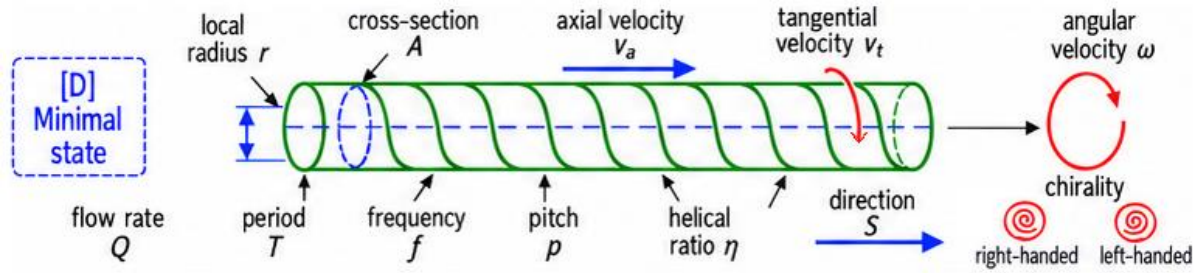
Chirality indicates the direction of winding relative to the chosen axial direction. In the first approximation, it may be treated as a discrete quantity:

$$\chi = \pm 1$$

This minimal set of variables may be written as:

$$\mathcal{S}_{hel} = \{r, A, v_a, v_t, \omega, Q, T, f, p, \eta, S, \chi\}$$

It defines the local kinematic state of helical flow. The Preda constants will be introduced as conserved relationships within this set. Not every variable must be constant. On the contrary, the variables may evolve. What must be conserved is the fundamental relationship among them.



[D] Definition of the minimal variables

A coherent helical flow is minimally described by its local radius, cross-section, axial velocity, tangential velocity, angular velocity, flow rate, period, frequency, pitch, helical ratio, axial direction, and chirality. The Preda constants do not fix each variable separately, but rather the relationships that allow these variables to adapt without loss of kinematic identity.

6.5. C_c — the fundamental constant of flow continuity

The first Preda constant is denoted by:

$$C_c$$

It describes the continuity of coherent helical flow. C_c does not mean merely the instantaneous volumetric flow rate, but the way the flow rate is preserved, increased, or reduced without destroying the system's identity.

Depending on its sign, C_c may also be interpreted as a geometrodynamic rate of expansion or contraction of volumetric transport. A positive value describes an increase in flow rate, a negative value describes its decrease, while the limit $C_c \rightarrow 0$ describes only an approach to a quasi-steady regime in which the flow rate remains nearly constant. Axialization is evaluated separately through η and transverse dispersion.

The starting point is the volumetric flow rate:

$$Q = A v_a,$$

where A is the cross-sectional area, and v_a is the axial velocity.

In the circular approximation:

$$A = \pi r^2,$$

whence:

$$Q = \pi r^2 v_a$$

This relation shows that the flow rate depends simultaneously on geometry and motion. If the tube radius changes, the cross-section changes. If the cross-section changes, the axial velocity must adapt for the flow regime to remain coherent.

In fluid mechanics, the continuity equation expresses conservation of mass. For variable density, the conserved quantity is the mass flow rate, not necessarily the volumetric flow rate Q . Only in an incompressible regime, without sources, capture, branching, or losses between two comparable cross-sections, does conservation of mass lead to the constancy of Q . For this reason, C_c is not identified here with the classical continuity equation; it is an additional geometrodynamic descriptor proposed for the variation of volumetric flow rate in the open system under analysis.

In a real tube, the flow rate may vary through capture, discharge, compressibility, entrainment of the medium, branching, or the choice of a moving cross-section. For the variation to be measurable without ambiguity, Q must be referenced to the same tracking rule: a local cross-section associated with the

coherent tube and a specified time interval. In the approximation $Q = \pi r^2 v_a$, the velocity v_a is the mean axial velocity over that cross-section, not necessarily the point velocity on the axis.

We denote the variation in flow rate by:

$$\dot{Q} = \frac{dQ}{dt}$$

In the Unified Theory, C_c is defined as the rate of change of the flow rate tracked through the same functional cross-section. Its invariant character is a postulate applied only over the coherent interval under analysis:

$$C_c = \dot{Q}_{\text{coherent}} = \frac{dQ}{dt},$$

with the conservation condition:

$$\frac{dC_c}{dt} = 0$$

The condition $\frac{dC_c}{dt} = 0$ is local to the regime: it states the constancy of C_c over a finite interval in which the cross-section, orientation, and measurement rule remain comparable. Fluid mechanics physically permits $C_c = 0$ for a nonzero steady flow rate. Through a domain postulate, the Unified Theory selects active states with $C_c \neq 0$, while the limit $C_c \rightarrow 0$ describes only a special quasi-steady regime. Axialization is defined independently, through the increase of the ratio $\eta = v_a/v_t$ and the reduction of transverse dispersion; it does not require $C_c \rightarrow 0$.

Dimensionally, from:

$$Q = A v_a$$

it follows:

$$[Q] = [A][v_a] = m^2 \frac{m}{s} = \frac{m^3}{s}$$

Therefore:

$$C_c = dQ/dt = m^3 \cdot s^{-2}$$

This dimension may be interpreted as the temporal rate of change of volumetric transport. It will allow C_c to be combined dimensionally with the other Preda constants in the internal state equation.

The sign of C_c separates three fundamental regimes.

For:

$$C_c > 0,$$

the flow rate increases, and the system is in a regime of expansion of volumetric transport.

For:

$$C_c < 0,$$

the flow rate decreases, and the system is in a regime of contraction of volumetric transport.

For:

$$C_c \rightarrow 0,$$

the flow rate is nearly constant. This is the regime with almost zero variation in flow rate. It does not express the absence of flow, but rather variation in flow rate approaching zero:

$$\frac{dQ}{dt} \rightarrow 0 \Rightarrow Q \rightarrow \text{constant.}$$

A tube may permanently transport a nonzero flow rate and simultaneously have $C_c \rightarrow 0$. The flow rate Q describes the existing transport, while C_c describes the increase, decrease, or stability of this transport.

In the active domain selected by the Unified Theory, C_c does not vanish. This is an explicit restriction of the model, not a prohibition imposed by fluid mechanics. The limits $C_c \rightarrow 0^+$ for expansion and $C_c \rightarrow 0^-$ for contraction describe the approach to a quasi-steady flow rate; the state $C_c = 0$ remains the steady state permitted by ordinary hydrodynamics. None of these limits defines axialization by itself.

If C_c is constant over the analyzed interval, from:

$$\frac{dQ}{dt} = C_c$$

it follows:

$$Q(t) = Q(t_0) + C_c(t - t_0)$$

For $C_c > 0$, the flow rate increases in a controlled manner. For $C_c < 0$, the flow rate decreases in a controlled manner. For $C_c \rightarrow 0$, the flow rate remains close to its initial value:

$$Q(t) \approx Q(t_0)$$

The linear relation is valid only over the finite interval in which C_c can be approximated as constant. It does not describe an unlimited increase or decrease in flow rate. When the regime changes, branching occurs, or the tracking protocol is modified, a new interval and possibly a new value of C_c must be defined.

Substituting the flow rate:

$$Q = \pi r^2 v_a,$$

we obtain:

$$C_c = \frac{d}{dt}(\pi r^2 v_a)$$

Differentiating:

$$C_c = \pi \left(2r v_a \frac{dr}{dt} + r^2 \frac{dv_a}{dt} \right)$$

Using the notations:

$$\dot{r} = \frac{dr}{dt}, \quad \dot{v}_a = \frac{dv_a}{dt},$$

the relation becomes:

$$C_c = \pi(2r v_a \dot{r} + r^2 \dot{v}_a)$$

This relation shows that variation in flow rate may be produced both by a change in radius and by a change in axial velocity. The expansion or contraction of transport is generally the result of the simultaneous adaptation of geometry and velocity.

For $Q \neq 0$, the relation may be written in relative form:

$$\frac{C_c}{Q} = 2 \frac{\dot{r}}{r} + \frac{\dot{v}_a}{v_a}$$

This form separates the contribution of geometric variation from the contribution of axial-velocity variation.

If the axial velocity is constant:

$$\dot{v}_a = 0,$$

then:

$$C_c = 2\pi r v_a \dot{r}$$

In this case, the sign of C_c coincides with the sign of $\dot{r}$. In the regime $\dot{r} > 0$ the tube expands transversely and the constant is positive. In the regime $\dot{r} < 0$ the tube contracts transversely and the constant is negative. The idealized case $\dot{r} = 0$, in which the radius and flow rate remain constant, corresponds to the mathematical boundary $C_c = 0$; for an active flow, the model uses the asymptotic approach $C_c \rightarrow 0$.

If the radius is constant:

$$\dot{r} = 0,$$

then:

$$C_c = \pi r^2 \dot{v}_a$$

In this regime, $C_c > 0$ describes the acceleration of axial transport, $C_c < 0$ describes its deceleration, and $C_c \rightarrow 0$ describes an axial velocity at a constant limit.

In the general case, geometry and axial velocity may change simultaneously. A tube may contract transversely yet increase its axial velocity sufficiently for the flow rate to increase. Conversely, a tube may expand while the flow rate decreases if the axial velocity decreases sufficiently. For this reason, the sign of C_c describes the expansion or contraction of volumetric transport, not necessarily only the variation in radius.

In the quasi-steady regime:

$$C_c \rightarrow 0,$$

and the adaptation relation becomes:

$$2 \frac{\dot{r}}{r} + \frac{\dot{v}_a}{v_a} \rightarrow 0$$

It follows:

$$\frac{\dot{v}_a}{v_a} \rightarrow -2 \frac{\dot{r}}{r}$$

If the radius decreases, the axial velocity must increase for the flow rate to remain nearly constant. If the radius increases, the axial velocity must decrease. Thus:

$$r^2 v_a \rightarrow \text{constant}$$

and:

$$Q = \pi r^2 v_a \rightarrow \text{constant}$$

In the IN region, C_c describes the way the flow is collected and compacted. If the captured flow rate increases, including through multiplication of the roots, C_c is positive. If the inflow is reduced, including through loss of roots, C_c is negative. If the capture regime stabilizes, C_c tends asymptotically toward zero without becoming zero in the domain of active flow.

In the transport region, C_c tends toward the value required by the tube's stable regime. For a quasi-steady flow rate, this value tends toward zero. For transport undergoing controlled expansion or contraction, C_c may remain constant and nonzero.

In the OUT region, the sign of C_c depends on the way the flow is transferred toward the attractor or redistributed into branches. The flow rate of one branch may increase while that of the main path decreases. Therefore, the value of C_c must always be referenced to the analyzed cross-section, path, and time interval.

Through this constant, the vortex tube is treated not as a simple rotating form, but as a transport system capable of expansion, contraction, or stabilization. Its identity depends on its capacity to keep the variation in flow rate controlled while its geometry changes.

In the state equation, which will be introduced later, C_c will appear squared. For this reason, its sign is not preserved by the number α that contains this constant. Information about expansion or contraction nevertheless remains present in the positive/negative value of C_c in the Preda triplet. The case $C_c \rightarrow 0$ is a limit of the parameterization through α , not a definition of axialization or evidence of a physical singularity.

[D] Definition

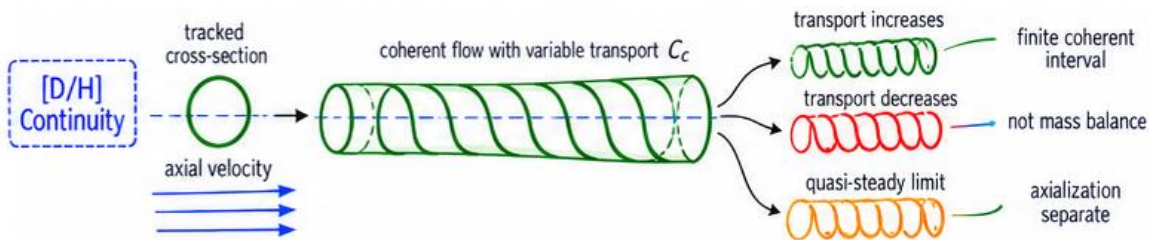
C_c is the Preda descriptor of the controlled variation of the volumetric flow rate in a coherent helical flow. It does not replace the mass balance and is meaningful only together with the functional cross-section, interval, and tracking rule used. In the model, it is interpreted as a geometrodinamic rate of expansion or contraction of transport:

$$C_c = \dot{Q}_{\text{coherent}} = \frac{dQ}{dt}.$$

Its unit of measurement is:

$$C_c = m^3 \cdot s^{-2}.$$

$C_c > 0$ describes the expansion of transport, $C_c < 0$ describes the contraction of transport, and $C_c \rightarrow 0$ describes the asymptotic limit of a quasi-steady flow rate. The zero value is not reached by an active flow within the model's postulated domain, while axialization is evaluated separately through kinematic observables.



[H] Postulate of conservation of C_c

[H] A coherent vortex tube is postulated to preserve its transport identity over a finite interval when changes in cross-section and axial velocity maintain an approximately constant rate of change of flow rate. C_c may be positive or negative, while the limit $C_c \rightarrow 0$ describes a nearly steady flow rate. For constant and nonzero C_c , $Q(t) = Q(t_0) + C_c(t - t_0)$, so the postulate cannot be extended unconditionally over the tube's entire lifetime.

6.6. C_f — the fundamental constant of kinematic form

The second Preda constant is denoted by:

$$C_f$$

It describes the kinematic form of helical flow. Kinematic form does not mean the visible geometric contour, but the relationship between the tube's transverse opening and the intensity of its rotation.

The starting point is the relationship among tangential velocity, local radius, and angular velocity:

$$v_t = r\omega$$

This relation shows that rotation cannot be separated from geometry. The same angular velocity produces different tangential velocities at different radii. Conversely, the same tangential velocity produces different angular velocities if the radius changes.

In a real flow, v_t generally varies with radius. Therefore, the pair r, v_t must be evaluated on the same coherent contour selected by a reproducible rule: for example, the core radius, the radius of a tracer line, or an effective radius defined from the cross-sectional profile. Without this sampling rule, C_f does not have a unique value for the entire tube.

This idea is compatible with the phenomenon known in fluid mechanics as vortex stretching. When a vortex tube is stretched, its cross-section may decrease while its internal rotation intensifies. In ideal fluids, conservation of circulation already provides a mechanism linking geometry and rotation. The Unified Theory does not identify C_f with circulation, but reformulates this connection as a proper constant of kinematic form.

The constant C_f is introduced as a proposed geometrodynamic invariant of this contour or orbital tracer. It is not derived here from conservation of circulation or angular momentum; the validity of its conservation must be verified for the class of flows analyzed:

$$C_f = rv_t^2$$

This quantity links transverse extent to rotational intensity. It describes neither geometry alone nor velocity alone. It describes a geometrodynamic relationship between the two.

Dimensionally:

$$C_f = rv_t^2 = m^3 \cdot s^{-2}$$

This dimension may be interpreted as the product of a geometric opening and the square of a velocity, that is, as a kinematic measure of the flow's capacity to maintain a rotating form within a given transverse opening.

If C_f is conserved, then:

$$rv_t^2 = \text{constant}$$

It follows that:

$$v_t^2 = \frac{C_f}{r}$$

and:

$$v_t = \sqrt{\frac{C_f}{r}}$$

This relation shows that if the radius decreases, the tangential velocity must increase for the kinematic form to be conserved. If the radius increases, the tangential velocity may decrease. The tube does not preserve the radius; it preserves the relationship between radius and rotation.

Using:

$$v_t = r\omega$$

we obtain:

$$C_f = r(r\omega)^2 = r^3\omega^2$$

Therefore:

$$\omega^2 = \frac{C_f}{r^3}$$

and:

$$\omega = \sqrt{\frac{C_f}{r^3}}$$

This shows that angular velocity increases faster than tangential velocity as the radius decreases. In a tube that narrows, rotation becomes more concentrated. In a tube that expands, rotation relaxes.

This relation explains why C_f is a constant of kinematic form. The form of the tube is not merely its contour, but the distribution of rotation relative to the radius. A coherent tube does not adapt

geometrically at random; it changes its radius, tangential velocity, and angular velocity so that its dynamic form remains compatible with its identity.

It is important not to confuse C_f with classical circulation. Circulation has the approximate form:

$$\Gamma \sim 2\pi r v_t$$

for a simplified circular contour. By contrast, C_f links the radius to the square of the tangential velocity:

$$C_f = r v_t^2$$

Therefore, C_f is not a simple rewriting of circulation. It is a proposed geometrodynamic quantity that describes another aspect of the flow: conservation of kinematic form during adaptation.

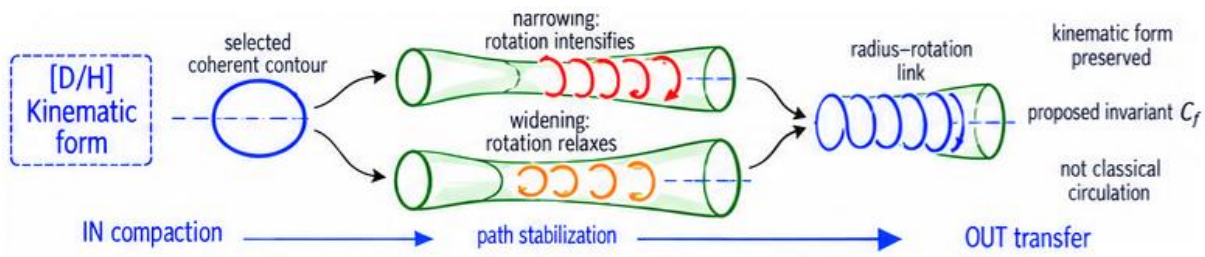
In the IN region, C_f controls flow compaction through the roots and the increase in rotation. In the transport region, C_f stabilizes the relationship between radius and rotation. In the OUT region, C_f conditions how the tube may branch or transfer the flow toward the attractor without an immediate loss of coherence.

Through this constant, geometry becomes the expression of a dynamic constraint. The tube has a form not because that form is drawn as a bounded domain in space, but because the relationship between radius and rotation is conserved.

[D] Definition

C_f is the fundamental constant of the kinematic form of coherent helical flow. It expresses the conserved relationship between the tube's local radius and the intensity of tangential rotation:

$$C_f = r v_t^2$$



[H] Postulate of conservation of C_f

A coherent vortex tube may change its radius and rotational distribution, but it preserves its kinematic form when the product of the local radius and the square of the tangential velocity remains constant. The visible form adapts; the geometrodynamic relationship is conserved.

6.7. C_e — the fundamental rotational constant of the internal cycle

The third Preda constant is denoted by:

$$C_e$$

It describes the internal cycle of coherent helical flow. If C_c expresses flow continuity and C_f expresses kinematic form through the relationship between local radius and tangential velocity, C_e expresses the relationship between the transverse scale of the tube and the ordinary frequency of its rotation.

A helical flow is neither merely displacement nor merely rotation. It is a cyclic process in which each complete rotation represents an internal unit of evolution. For the tube to preserve its identity during adaptation, changes in radius must remain correlated with changes in frequency.

The starting point is ordinary frequency, denoted by:

$$f$$

It represents the number of complete cycles performed per unit time and is measured in hertz. If T is the period of one complete rotation, then:

$$f = \frac{1}{T}$$

The angular frequency is:

$$\omega = 2\pi f,$$

and the local tangential velocity is:

$$v_t = r\omega = 2\pi r f$$

These relations show that frequency cannot be separated from the local geometry of the flow. The same frequency produces different tangential velocities at different radii. Conversely, the same tangential velocity corresponds to different frequencies when the radius changes.

In a coherent vortex tube, the local radius is not fixed. The tube may narrow, expand, bend, or adapt to the environment. If the radius changes, the frequency of the internal cycle must change in a manner compatible with preserving the geometrodynamic state.

In the mechanics of rotating systems, frequency, angular velocity, and tangential velocity are established kinematic quantities. The product $r^3 f^2$ is introduced here as a proposed geometrodynamic invariant, evaluated at the same tracer radius used for C_f . It describes the rotational scale of the internal cycle; by itself it contains neither axial velocity nor helical pitch and is not, on its own, a complete invariant of helicity.

In the formulation of the Unified Theory, the fundamental rotational constant of the internal cycle is:

$$C_e = r^3 f^2$$

Here r represents the scalar local radius of the flow. If the radial position is expressed by the vector $\mathbf{r}$, then its magnitude is used in the formula:

$$C_e = \|\mathbf{r}\|^3 f^2$$

This quantity links the tube's transverse extent to the rhythm of rotation. It describes neither geometry alone nor frequency alone. It describes the geometrodynamic relationship between the volume scale associated with the radius and the temporal cycle of the flow.

Dimensionally:

$$C_e = r^3 f^2 = m^3 \cdot s^{-2}$$

Therefore, C_e has the same physical dimension as C_c and C_f :

$$[C_c] = [C_f] = [C_e] = L^3 T^{-2} = m^3 \cdot s^{-2}$$

If C_e is conserved, then:

$$r^3 f^2 = \text{constant.}$$

It follows that:

$$f^2 = \frac{C_e}{r^3}$$

and:

$$f = \sqrt{\frac{C_e}{r^3}}$$

This relation shows that if the radius decreases, the frequency must increase for the internal cycle to be conserved. If the radius increases, the frequency may decrease. The tube conserves neither radius nor frequency separately; it conserves the relationship between them.

The corresponding scaling law is:

$$f \propto r^{-3/2}$$

The differential conservation condition may be obtained from:

$$\frac{dC_e}{dt} = 0$$

For $C_e = r^3 f^2$, it follows:

$$3r^2 f^2 \frac{dr}{dt} + 2r^3 f \frac{df}{dt} = 0,$$

or, in relative form:

$$3 \frac{\dot{r}}{r} + 2 \frac{\dot{f}}{f} = 0$$

This equation expresses the simultaneous adaptation of radius and frequency. A geometric variation imposes a variation in the rhythm of the cycle, while a frequency variation must be compensated geometrically.

The constant C_e may also be written as a function of the cycle period:

$$C_e = \frac{r^3}{T^2}$$

Using $\omega = 2\pi f$, we obtain:

$$C_e = \frac{r^3 \omega^2}{4\pi^2}$$

Since $v_t = r\omega$, the following form is also obtained:

$$C_e = \frac{rv_t^2}{4\pi^2}$$

These forms do not change the definition of the constant. They show only that the same cyclic state may be read through ordinary frequency, angular frequency, or tangential velocity. The complete relationship between C_e and C_f will be analyzed in the following subsection, when the three constants are combined into the Preda triplet.

The helical pitch is:

$$p = v_a T = \frac{v_a}{f}$$

It follows that:

$$f = \frac{v_a}{p},$$

and the constant may also be expressed as:

$$C_e = r^3 \left(\frac{v_a}{p} \right)^2$$

This form shows that the internal cycle may also be tracked through the relationship between axial advance and helical pitch. However, C_e must not be confused with the dimensionless helical ratio:

$$\eta = \frac{v_a}{v_t} = \frac{p}{2\pi r}$$

C_e describes the frequency–radius scale of the cycle, while η describes the geometric proportion between axial advance and tangential rotation.

In the IN region, C_e describes how a captured flow, through the convergence of roots, organizes its radius and frequency at the tube inlet in order to form a coherent cycle. Transverse compaction may be accompanied by an increase in frequency, while expansion may be accompanied by its reduction.

In the transport region, C_e describes the stability of the internal rhythm. The radius may undergo local adaptations, but the frequency must respond so that the product $r^3 f^2$ remains within the limits of coherence.

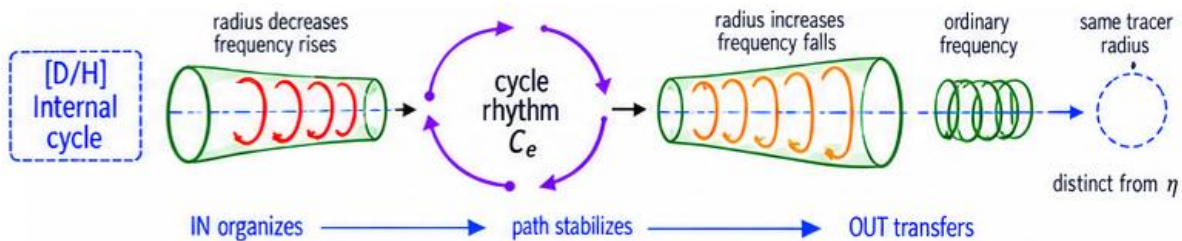
In the OUT region, C_e conditions how the flow cycle may be transferred toward the attractor, toward a branch, or toward a secondary structure. If the new region cannot receive the rhythm of the cycle, the flow reconfigures or loses its former identity.

Through C_e , the internal time of rotation becomes part of the geometrodynamic state. The tube is described neither solely by its form nor solely by its velocities, but also by the rhythm with which it traverses its own cycle.

[D] Definition

C_e is the fundamental rotational constant of the internal cycle of coherent flow. It expresses the conserved relationship between local radius and the ordinary frequency of rotation:

$$C_e = r^3 f^2$$



[H] Postulate of conservation of C_e

A coherent vortex tube preserves its internal cycle when the product of the cube of the local radius and the square of the orbital frequency remains constant. Radius and frequency may adapt, but the geometrodynamic relationship between transverse scale and cycle rhythm must be conserved.

6.8. The Preda triplet as kinematic identity

The three constants introduced above must not be regarded as three independent degrees of freedom. C_c describes the variation in volumetric transport, while C_f and C_e provide two operational ways of reading the same local rotational constraint: through tangential velocity and frequency, respectively. The triplet is useful experimentally because one of the two rotational quantities may be accessible when the other is not measured, but its scalar core has only two independent constraints.

The Preda constants are:

$$\begin{aligned} C_c &= \left(\frac{dQ}{dt} \right)_{\text{coherent}}, \\ C_f &= r v_t^2, \\ C_e &= r^3 f^2 \end{aligned}$$

They are combined into the state triplet:

$$C_P = (C_c, C_f, C_e)$$

Within the model, this triplet represents the proposed measurable core of kinematic identity. It preserves three channels of determination, but is constrained by the relation $C_f = 4\pi^2 C_e$ when the measurements refer to the same rotation and the same radius. The coherence of the triplet must be verified experimentally, not assumed from mere dimensional compatibility.

The three constants have the same physical dimension:

$$[C_c] = [C_f] = [C_e] = L^3 T^{-2} = m^3 \cdot s^{-2}$$

This dimensional identity is important. The constants may be compared within the state relation without being artificially transformed into quantities of a different nature. Their normalization may be useful when comparing systems at very different scales, but it is not required for the dimensional consistency of the triplet.

C_c describes the active continuity of volumetric transport. Its sign shows the direction of variation in flow rate: a positive value indicates intensification of volumetric transport, while a negative value indicates its reduction. Within the postulated active domain, C_c remains nonzero; its magnitude may tend asymptotically toward zero in a quasi-steady regime without the process becoming motionless. This limit is not a condition of axialization:

$$|C_c| \rightarrow 0, \quad C_c \neq 0$$

C_f describes the kinematic form of rotation through the product of local radius and the square of tangential velocity. If C_f is conserved, radius and tangential velocity adapt according to the relation:

$$r v_t^2 = \text{constant}$$

C_e describes the internal cycle through the product of the cube of the radius and the square of ordinary frequency. If C_e is conserved, radius and frequency adapt according to the relation:

$$r^3 f^2 = \text{constant}$$

The new definition of C_e requires clarification of its relationship with C_f . For ordinary frequency f , angular velocity and tangential velocity are:

$$\omega = 2\pi f,$$

$$v_t = r\omega = 2\pi r f$$

Substituting this expression into the definition of C_f , it follows:

$$C_f = r(2\pi r f)^2,$$

that is:

$$C_f = 4\pi^2 r^3 f^2$$

Since $C_e = r^3 f^2$, the structural relation is obtained:

$$C_f = 4\pi^2 C_e,$$

or, equivalently:

$$C_e = \frac{C_f}{4\pi^2}$$

This relation does not negate the role of either constant. C_f reads the rotational state through tangential velocity, while C_e reads it through the cycle frequency. They express two complementary representations of the same local rotational organization. However, they are not algebraically independent when r , v_t and f refer to the same local radius and the same cycle.

For the independent state vectors used later, the rotational descriptor C_r is defined. It is not a fourth constant: it represents the same constraint reported directly through C_f or indirectly through C_e :

$$C_r \equiv C_f = 4\pi^2 C_e$$

The three symbols C_c , C_f , and C_e remain necessary because they separate three operational pathways: variation in flow rate, measurement of rotation through tangential velocity, and measurement of the same rotation through frequency. C_r is used only to avoid duplicating information in minimal vectors; whenever possible, C_f and C_e are reported separately and the relation between them is verified.

This clarification definitively separates C_e from the dimensionless helical ratio. The ratio between axial transport and tangential motion remains:

$$\eta = \frac{v_a}{v_t} = \frac{p}{2\pi r}$$

η describes the kinematic orientation of the helix, while C_e describes the frequency–radius relationship of the internal cycle. Therefore:

$$C_e \neq \eta$$

The new definition of C_e does not by itself determine the axial velocity v_a or the pitch p . For a complete description of the flow, the Preda triplet must be accompanied by the ratio η , the axial direction S , and the chirality χ . The triplet defines the primary invariant core, while these quantities complete the orientation and effective helical geometry.

In a coherent regime, conservation of the triplet may be written as:

$$\frac{dC_P}{dt} = 0,$$

or, explicitly:

$$\frac{dC_c}{dt} = 0, \quad \frac{dC_f}{dt} = 0, \quad \frac{dC_e}{dt} = 0$$

This formulation applies to a specific coherent state. It does not mean that radius, velocities, frequency, pitch, or instantaneous flow rate remain unchanged. Local variables may change, but their changes must preserve the relationships defined by the constants.

Conservation of C_f leads to:

$$\frac{\dot{r}}{r} + 2 \frac{\dot{v}_t}{v_t} = 0,$$

while conservation of C_e leads to:

$$3 \frac{\dot{r}}{r} + 2 \frac{\dot{f}}{f} = 0.$$

The two relations are compatible. From $v_t = 2\pi r f$ it follows:

$$\frac{\dot{v}_t}{v_t} = \frac{\dot{r}}{r} + \frac{\dot{f}}{f}$$

By substitution, the conservation equation for C_f becomes precisely the conservation equation for C_e . This equivalence confirms that the two constants describe the same rotational constraint through different variables.

Here the difference between geometry and identity appears. Geometry is the instantaneous configuration of the flow. The Preda triplet is the internal rule through which variation in flow rate and

rotational organization remain coherent during transformation. The tube may bend, narrow, expand, or deviate, but it preserves its primary identity as long as its fundamental relationships are conserved.

This perspective makes it possible to classify flows without confusing their instantaneous appearance with their internal state. Two flows with different visible geometries may belong to the same family if they preserve compatible triplet values and the same constraint $C_f = 4\pi^2 C_e$. Conversely, two apparently similar flows may have different values of C_c or of the rotational level and may belong to different geometrodynamic states.

However, the triplet must be used together with the orientation descriptors. Two flows may have the same Preda triplet but different values of η , opposite axial directions, or different chiralities. They have the same dimensional core of state, but not the same complete helical state and not necessarily the same interaction compatibility.

[D] Definition

The Preda triplet is the proposed operational set of coherent helical flow: three measurable quantities, but only two independent scalar constraints when C_f and C_e describe the same local rotation:

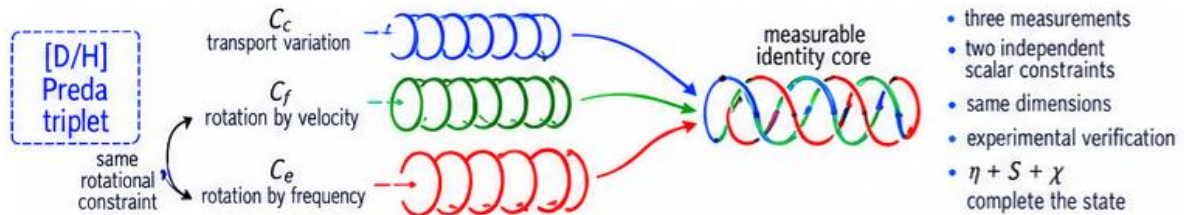
$$\mathbf{C}_P = (C_c, C_f, C_e),$$

with the definitions:

$$C_c = \left(\frac{dQ}{dt} \right)_{\text{coherent}}, \quad C_f = r v_t^2, \quad C_e = r^3 f^2,$$

and with the mandatory internal relation:

$$C_f = 4\pi^2 C_e$$



[H] Postulate of the Preda triplet

The primary kinematic identity of a coherent helical flow is defined through conservation of the triplet $\mathbf{C}_P = (C_c, C_f, C_e)$. The triplet is constrained by the relation $C_f = 4\pi^2 C_e$, because kinematic form and the internal cycle represent two readings of the same rotational organization. The geometric and kinematic variables may adapt, but the flow preserves its identity only as long as it conserves the triplet and remains compatible with its helical ratio, axial direction, and chirality.

6.9. The dimensionless internal state relation of helical flow

After defining the constants, the internal state equation must be formulated. It must not be confused with an interaction equation proper. The state relation describes the internal ratio through which a coherent helical flow preserves its identity during geometric adaptation. Interaction between two flows will be analyzed only in the following chapter.

The local state of helical flow was described through the minimal set of variables:

$$\mathcal{S}_{hel} = \{r, A, v_a, v_t, \omega, Q, T, f, p, \eta, S, \chi\}$$

This set contains geometric, kinematic, and discrete variables. Radius and cross-section describe the transverse opening. Axial and tangential velocities describe transport and rotation. Period, frequency, and pitch describe the cycle. Axial direction and chirality describe functional orientation.

The Preda constants are extracted from this state. In general form, we may write:

$$\mathbf{C}_P = \Phi(\mathcal{S}_{hel})$$

where Φ represents the mapping through which the system's conserved relationships are obtained from the flow variables.

In the basic formulation, the Preda triplet remains:

$$\mathbf{C}_P = (\mathbf{C}_c, \mathbf{C}_f, \mathbf{C}_e)$$

and its internal relationships may be written as a system of constraints:

$$\begin{cases} \mathbf{C}_c = \dot{Q}_{coherent} = \frac{d}{dt}(A v_a) \\ \mathbf{C}_f = r v_t^2 \\ \mathbf{C}_e = r^3 f^2 \end{cases}$$

The first relation expresses the controlled variation of flow rate. The second and third express the same rotational constraint through tangential velocity and frequency. The third is not the complete helical ratio because it does not contain the axial component; the helical ratio remains η . These relations define the constrained triplet and prepare a dimensionless state descriptor.

The complete form of the state relation appears when the three constants are combined into a single state ratio. This ratio is the number α :

$$\alpha = \frac{\mathbf{C}_e \cdot \mathbf{C}_f}{\mathbf{C}_c^2}$$

Written equivalently, the relation becomes:

$$\alpha \mathbf{C}_c^2 = \mathbf{C}_e \cdot \mathbf{C}_f$$

This is the definition of the dimensionless state relation proposed in the Unified Theory. Algebraically, the formula defines α from $\mathbf{C}_c$, $\mathbf{C}_f$ and $\mathbf{C}_e$; it is not yet a dynamic equation and does not by itself produce the tube's evolution. The physical role of α must be established through measurable consequences and comparison with the actual dynamics of the flow.

α is a pure number, without a unit of measurement, because $\mathbf{C}_c$, $\mathbf{C}_f$, and $\mathbf{C}_e$ have the same unit, $\text{m}^3 \cdot \text{s}^{-2}$, while the ratio $(\mathbf{C}_e \cdot \mathbf{C}_f) / \mathbf{C}_c^2$ is dimensionally neutral. Normalization may optionally be used to compare systems at very different scales, but it is not required for α to be dimensionless.

This clarification is important. $\mathbf{C}_c$, $\mathbf{C}_f$ and $\mathbf{C}_e$ enter the ratio α through values expressed in the same system of units. The result is a dimensionless number. *However, dimensionality alone does not automatically imply that α controls coupling or indicates a physical transition; these two interpretations are additional hypotheses of the model.*

The analogy with gears, which need the same module m to mesh, remains useful for intuition but does not constitute proof. The model formulates the hypothesis that proximity of α values is a necessary coupling condition, with α potentially playing the role of a dimensionless compatibility parameter. It is not sufficient: axis orientation, axial direction, chirality, phase, distance, and the dynamic mechanism of interaction must be verified separately.

In the coherent regime, the model postulates conservation of the triplet over the analyzed interval:

$$\frac{d\mathbf{C}_P}{dt} = 0$$

and through conservation of the state ratio:

$$\frac{d\alpha}{dt} = 0$$

If $\mathbf{C}_c$, $\mathbf{C}_f$ and $\mathbf{C}_e$ are conserved, then $\frac{d\alpha}{dt} = 0$ follows algebraically from the definition of α and does not add an independent law. Local variables may change, but they must obey the triplet's two independent scalar constraints and the additional orientation descriptors.

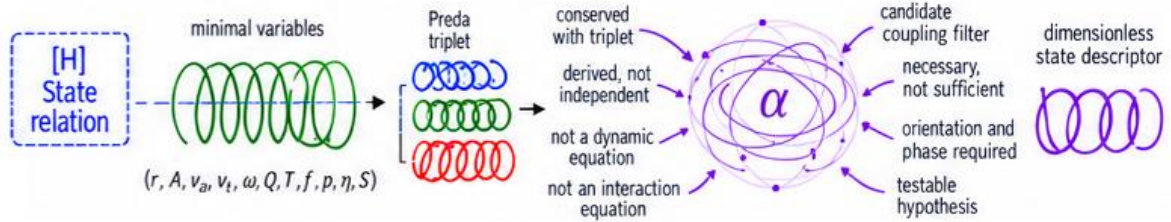
To avoid redundancy, subsequent comparisons use the independent vector

$$\mathbf{S}_{ind} = (\mathbf{C}_c, \mathbf{C}_r, \eta, \mathbf{S}, \chi, \phi, \dots), \text{ where } \mathbf{C}_r \equiv \mathbf{C}_f = 4\pi^2 \mathbf{C}_e,$$

and α is calculated from $\mathbf{C}_c$ and the rotational descriptor. The Preda triplet remains the operational reporting set. Adaptation keeps the vector within tolerance limits; stress and decoherence arise when one or more independent components leave the domain of the state.

Through this relation, the vortex tube receives a testable formal description, but it does not yet become a completely calculable dynamic system. This also requires evolution equations, initial and boundary conditions, environmental parameters, and quantitative predictions that can be compared with data.

Nevertheless, this formalization must be kept within its limits. The state relation does not yet describe the concrete type of interaction between two flows. It does not yet describe induction, complete branching, or the fundamental kernels. It describes the condition for a tube to remain itself and possibly be compatible for coupling with another tube.



[H] Hypothesis of the state relation through α

The proposed dimensionless state relation is $\alpha = (C_e \cdot C_f)/C_c^2$. The Preda triplet defines the input quantities, while α is their derived descriptor. Conservation of α follows from conservation of the triplet; the additional hypothesis, which must be tested, is that proximity of α values constitutes a necessary coupling condition between flows.

6.10. Geometric adaptation imposed by conservation of the constants

Conservation of the Preda constants has an immediate consequence: geometry cannot remain arbitrary. If the triplet C_P must be conserved, then radius, tangential velocity, frequency, axial velocity, and flow rate must adapt without the definitions of the three constants being confused. Geometry changes in order to protect kinematic identity.

This idea can be shown through the basic relations. From the definition of C_f we have:

$$C_f = r v_t^2$$

If C_f is conserved, it follows:

$$v_t = \sqrt{\frac{C_f}{r}}$$

Therefore, reducing the radius requires an increase in tangential velocity, while increasing the radius permits a decrease in tangential velocity. The tube does not conserve radius, but the relationship between radius and rotation.

From the definition of C_e we have:

$$C_e = r^3 f^2$$

If C_e is conserved, it follows:

$$f = \sqrt{\frac{C_e}{r^3}}$$

In differential form, the same condition is written:

$$\frac{\dot{f}}{f} = -\frac{3}{2} \frac{\dot{r}}{r}$$

Therefore, reducing the radius requires an increase in ordinary frequency, while increasing the radius permits its reduction. Conservation of C_e determines the adaptation of frequency, not axial velocity. Axial velocity cannot be deduced from C_e without an additional relation.

For the axial component and flow rate, the basic geometric relation remains:

$$Q = \pi r^2 v_a$$

Differentiating with respect to time gives:

$$\frac{dQ}{dt} = \pi(2r\dot{r}v_a + r^2\dot{v}_a)$$

By the definition of C_c :

$$C_c = \pi(2r\dot{r}v_a + r^2\dot{v}_a)$$

This relation shows that variation in flow rate is not determined by radius alone. Radius and axial velocity may change simultaneously: transverse contraction may be accompanied by an increase in axial velocity, while expansion may be accompanied by its decrease.

In a state in which C_c is constant, the flow rate evolves linearly locally:

$$Q(t) = Q(t_0) + C_c(t - t_0)$$

For nonzero Q , the relative form is:

$$\frac{C_c}{Q} = 2 \frac{\dot{r}}{r} + \frac{\dot{v}_a}{v_a}$$

The sign of C_c describes the direction of variation in volumetric transport: a positive value indicates increasing flow rate, while a negative value indicates its decrease. The sign does not necessarily describe only the variation in radius, because the contribution of axial velocity remains explicit.

In the special quasi-steady regime, C_c tends toward zero without being considered physically zero within the postulated active domain, and the adaptation condition becomes:

$$C_c \rightarrow 0 \Rightarrow 2\frac{\dot{r}}{r} + \frac{\dot{v}_a}{v_a} \rightarrow 0$$

Only in the exactly steady ideal limit, used as a mathematical approximation, do we obtain:

$$\frac{d}{dt}(r^2 v_a) = 0, \quad \frac{dQ}{dt} = 0$$

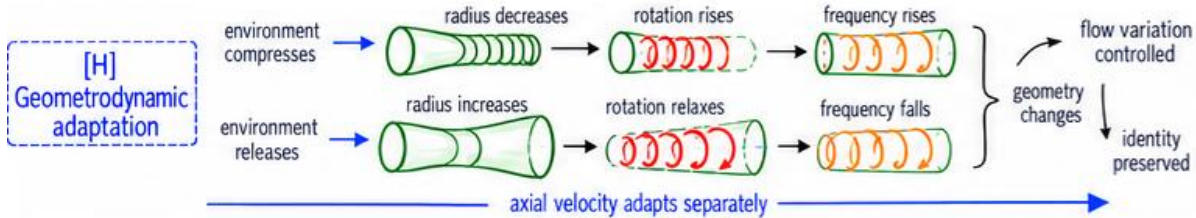
Thus, if the radius decreases, the axial velocity must increase sufficiently for the flow rate to remain nearly constant; if the radius increases, the axial velocity must decrease. In the general regime, the two contributions may produce either an increase or a decrease in flow rate.

Conservation of C_f requires correlation of radius with tangential velocity; conservation of C_e requires correlation of radius with frequency; while C_c constrains the evolution of flow rate through simultaneous variations in radius and axial velocity. The three constants retain their own definitions and operational pathways of determination. However, when C_f and C_e describe the same local rotation at the same radius, they are linked by the relation $C_f = 4\pi^2 C_e$ and do not introduce two independent degrees of freedom.

This conclusion is compatible with established observations of vortices: a stretched, compressed, or deflected tube changes its internal distribution of rotation. In the Unified Theory, this change is formulated more strictly: geometric adaptation is a consequence of conservation of the Preda triplet.

At this point, geometry becomes the regulating variable of the flow. If the environment compresses the tube, conservation of C_f requires an increase in tangential velocity, while conservation of C_e requires an increase in frequency. Axial adaptation is described separately through C_c . Helical pitch and the axial–tangential ratio remain additional descriptors and are no longer identified with C_e .

Therefore, conservation of the constants is not a static formula. It is a law of transformation. The system may change, but not arbitrarily. Every geometric change must remain compatible with kinematic identity.



[H] The proposition of geometrodynamical adaptation

Conservation of the Preda triplet requires simultaneous but distinct adaptations: radius and tangential velocity are correlated through C_f , radius and frequency through C_e , while C_c constrains the evolution of flow rate through simultaneous changes in radius and axial velocity. The tube's geometry changes in order to conserve the fundamental constants of coherent helical flow, without confusing their respective roles.

6.11. IN–path–OUT in relation to the Preda constants

Coherent helical flow must not be analyzed as a structure uniform along its entire length. It has distinct functional regions: IN, the path, and OUT toward the attractor. Each region has a different role in relation to the Preda constants.

The IN region is the region of capture, convergence, and preparation of the flow. Here the system receives matter, momentum, or information from the external environment. Geometry may be highly variable, and the flow may pass from a dispersed regime to a more organized one. In this region, C_c controls how variation in flow rate becomes compatible with entry into the tube.

In IN, the effective radius may decrease or increase, while constituent lines may multiply or diminish. If C_f must be preserved, reducing the radius requires intensification of the tangential component. If C_e must be preserved, increasing rotation must be correlated with radius–frequency adaptation. Thus, the IN region is where the flow is compelled to construct its kinematic identity.

The path is the region of coherent transport. Here the Preda constants tend to manifest most clearly. Variation in flow rate is minimal and controlled, kinematic form is stabilized, and the relationship between local radius and cycle frequency is preserved. This is the region in which the flow most closely approaches the ideal regime.

Along the path, the tube need not be perfectly straight or perfectly uniform. It may have undulations, variations in cross-section, and local adaptations. Nevertheless, these changes are compatible with conservation of the triplet. Therefore, the path may be regarded as the region of maximum flow identity.

The OUT region is not simple dispersion. Within the Unified Theory, OUT represents the conduction of the flow toward the attractor or toward compatible regions for receiving transport. Here the flow may be discharged, branched, transferred, or coupled with other structures. But as long as the system remains coherent, this transition must preserve compatibility with the Preda triplet.

This IN–path–OUT architecture may also be analyzed in the spirit of control volumes in fluid mechanics. Any balance of flow rate, momentum, or energy requires establishing a boundary through which quantities enter and exit. In the Unified Theory, the boundary is not merely a geometric surface but a functional region of the flow: IN introduces, the path organizes, and OUT conducts toward the attractor.

From this perspective, the Preda constants are not uniformly distributed like mechanical values imposed from outside. They are maintained through the function of each region. IN prepares the flow for conservation. The path achieves maximum conservation. OUT tests the flow's capacity to be transferred without loss of identity.

If the flow cannot be organized in the IN region, the tube does not form. If the constants cannot be preserved along the path, the tube does not persist. If the transfer at OUT is incompatible, the system reconfigures or loses coherence.

Therefore, the IN–path–OUT architecture is not merely a descriptive scheme. It is the functional framework within which the Preda constants may be conserved. Without this architecture, the triplet remains abstract. With this architecture, the triplet becomes the internal state of a transport system.

[D] Definition — the functional IN–path–OUT architecture

The Preda constants manifest differently in the tube's functional regions: IN organizes compatible filamentary inputs and variation in flow rate, the path stabilizes conservation, and OUT conducts the flow toward the attractor or toward compatible receiving regions. The system's kinematic identity depends on the compatibility of these regions.

6.12. Geometric stress and the limit of conservation

A coherent helical flow cannot conserve the Preda triplet indefinitely under all conditions. The external environment may impose deformations, variations in flow rate, lateral perturbations, changes in local chirality, incompatible interactions, or reconnections. All of these produce geometric stress.

Geometric stress must not be understood as mechanical stress in a solid. The vortex tube is not a rigid body. Geometric stress is the difference between the geometry imposed by the environment and the geometry required to conserve the constants. It appears when the system is forced to deform in a manner that endangers its identity triplet.

If the deformation is small, the tube can respond through adaptation. The radius changes, the velocities adjust, the helical pitch changes, and the constituent lines redistribute rotation. If the triplet is preserved, the system remains coherent.

If the deformation increases, adaptation becomes more difficult. The system must simultaneously compensate for variation in flow rate, kinematic form, and the relationship between local radius and cycle frequency. At a certain level, these compensations can no longer be satisfied simultaneously.

We may denote the deviation of the triplet by:

$$\Delta \mathbf{C}_P = (\Delta \mathbf{C}_c, \Delta \mathbf{C}_f, \Delta \mathbf{C}_e)$$

In a coherent regime, this deviation must remain below an admissible threshold:

$$\| \Delta \mathbf{C}_P \| \leq \epsilon_C$$

where ϵ_C represents the system's coherence tolerance.

If the deviation exceeds the threshold:

$$\| \Delta \mathbf{C}_P \| > \epsilon_C$$

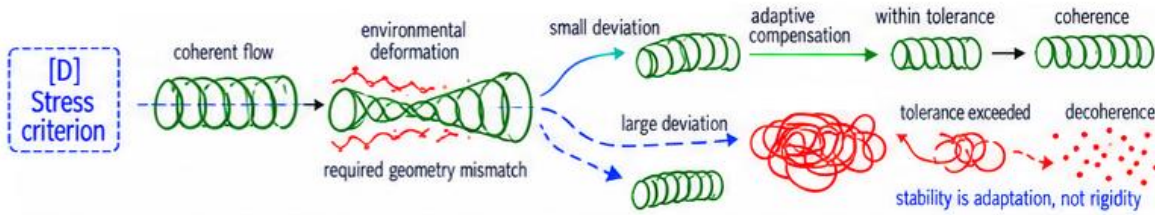
then the flow can no longer be regarded as the same kinematic state. Geometry no longer succeeds in conserving the triplet, and the system enters the domain of decoherence.

This formulation is important because it avoids an error. Not every local variation destroys the tube. A coherent system can withstand fluctuations, perturbations, and deformations. It is destroyed only by a variation that exceeds the adaptive capacity of the triplet.

In this sense, stability is not rigidity. Stability is the system's capacity to keep $\|\Delta\mathbf{C}_P\|$ below the coherence threshold. A tube that is geometrically very rigid but unable to adapt its velocities may rapidly lose coherence. A flexible tube capable of preserving its constants may remain coherent.

Geometric stress also explains why flows have many roots and then branch, with vortex lines becoming visible at their ends. If a single path can no longer conserve the triplet, the system may redistribute transport into branches and roots. Coherent branching becomes a solution for reducing stress. Incoherent fragmentation occurs when even branching can no longer preserve identity.

Through this notion, the Unified Theory introduces a clear boundary between adaptation and the failure of adaptation. As long as geometric stress can be compensated, the flow remains the same. When stress exceeds the coherence tolerance, the old state is lost.



[D] Criterion of geometric stress

Geometric stress occurs when deformations imposed on the flow tend to change the Preda triplet beyond the system's coherence threshold. Adaptation is possible as long as the deviation of the constants remains below this limit; exceeding the threshold leads to decoherence.

6.13. Decoherence and the emergence of a new set of constants

Decoherence is not the disappearance of flow, but the loss of its former kinematic identity. A vortex tube may cease to be the same system even if the fluid continues to move and even if local rotations still exist. What is lost is conservation of the Preda triplet.

In the coherent regime we have:

$$\frac{d\mathbf{C}_P}{dt} = 0$$

When the system can no longer conserve the triplet, the following appears:

$$\frac{d\mathbf{C}_P}{dt} \neq 0$$

If this deviation is local and temporary, the system may recover through adaptation. If the deviation persists or exceeds the coherence threshold, the tube loses its identity.

This loss may take several forms. The tube may fragment into smaller vortices. It may reconnect. It may transform into an intermediate turbulent flow, or it may form a new coherent tube with different constant values.

If a new coherent state appears, it will be described by a new triplet:

$$\mathbf{C}_P' = (\mathbf{C}_c', \mathbf{C}_f', \mathbf{C}_e')$$

This new set is not a simple variation of the old set, but the sign of a new kinematic identity. The previous system has disappeared; the new system has been born.

Therefore, the complete process may be written conceptually as follows:

$$\mathbf{C}_P \rightarrow \text{geometric stress} \rightarrow \text{decoherence} \rightarrow \mathbf{C}_P'$$

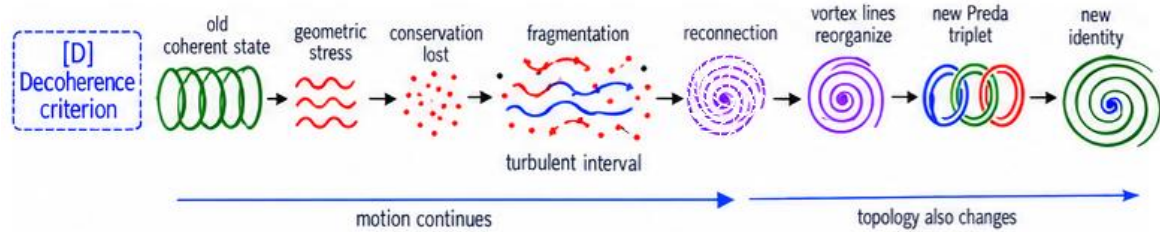
This sequence must not be interpreted as an arbitrary jump. Between the old set and the new set there is a physical transition: loss of conservation, geometric redistribution, reorganization of vortex lines, and stabilization of a new flow. But the old identity does not continue without rupture.

This idea is compatible with the logic of reconnection in topological hydrodynamics. When vortex lines change their connectivity, the old topological memory changes. In the Unified Theory, in addition to this topological change, the kinematic triplet also changes. Reconfiguration is therefore simultaneously topological and geometrodynamical.

Decoherence must not be regarded as absolute failure. It is the mechanism through which nature abandons a state that can no longer conserve its parameters and seeks a new state. From this perspective, the evolution of vortex systems may be read as a succession of coherent states separated by episodes of decoherence.

Here the geometrodynamic meaning of selection appears. Not all configurations persist. Those that can conserve the triplet under the conditions imposed by the environment persist. Incompatible configurations disintegrate or transform. This is the primary form of selection through coherence.

Therefore, the Preda constants describe not only stability, but also the death and rebirth of flow states. They state what must be preserved for the system to remain the same and what changes when the system becomes another.



[D] Criterion of geometrodynamic decoherence

A vortex tube loses its identity when it can no longer conserve the Preda triplet. Decoherence does not cancel the flow, but ends the former kinematic state and may allow a new state, defined by a new set of fundamental constants, to emerge.

6.14. The state number α — dimensionless relation, coupling hypothesis, and limits of the parameterization

The Preda triplet describes the internal identity of a coherent vortex tube. However, no natural tube exists in complete isolation. It may encounter other flows, induce secondary structures, be captured by an attractor, or enter bundles and chains of flows. This transition from state to relationship requires an active interpretation of the number α .

α is not a fourth independent constant placed alongside C_c , C_f and C_e . It is the state ratio derived from the Preda triplet:

$$\alpha = \frac{C_e \cdot C_f}{C_c^2}$$

or, equivalently:

$$\alpha C_c^2 = C_e \cdot C_f,$$

$$\text{From the reduced form } C_f = 4\pi^2 C_e$$

it becomes:

$$\alpha = \frac{4\pi^2 C_e^2}{C_c^2}$$

The relation gives α a mathematically demonstrated role within the definitions: it is a derived dimensionless ratio. The theory additionally assigns it two hypothetical roles: a necessary coupling criterion and an indicator of proximity to a state boundary. These roles do not follow from the formula alone and must be validated through interaction dynamics and differential tests.

α is a pure number and, because C_c appears squared, it does not preserve the sign of expansion or contraction. It also does not contain axial direction, chirality, or phase. At most, it may function as a partial scalar descriptor of the state; complete compatibility requires the signed triplet and the orientation descriptors.

In current physics, a coupling constant appears in a dynamic law, a Lagrangian, or an interaction amplitude and controls its intensity. α does not yet have this status. This volume tests only the geometrodynamic hypothesis that the value of α may participate in the preliminary selection of states that are candidates for coupling.

For two flows i and j , lateral compatibility may be expressed by:

$$\alpha_i = \alpha_j$$

Within the hypothesis, equality of the α values is an idealized necessary condition for participation in the same scalar coupling regime. It does not guarantee interaction and must be supplemented by measured tolerances, orientation, chirality, phase, and environmental conditions.

For axial continuity, the condition is stricter. Two flows that must connect end to end in a coherent chain cannot merely have the same α . They must also have the same internal kinematic identity:

$$(C_c, C_r, \eta, S, \chi, \varphi)[i] = (C_c, C_r, \eta, S, \chi, \varphi)[j]$$

This formulation expresses the difference between coupling compatibility and state identity. Compatibility through α may be necessary as a preliminary scalar filter for lateral alignment, but it is not sufficient. Congruence of the entire set is necessary for axial continuity.

At this stage, the connection with the Σ_{gd} regime is only diagnostic. If C_c tends toward zero while C_e and C_f remain nonzero, the ratio defined for α diverges algebraically:

$$C_c \rightarrow 0 \Rightarrow \alpha \rightarrow \infty$$

Divergence of the ratio does not demonstrate the existence of a physical singularity. It shows that the parameterization through α becomes unsuitable at the boundary $C_c = 0$. The boundary is not identified with axialization; any interpretation as a state transition remains a separate physical hypothesis requiring a regularized evolution equation and finite observables.

Conversely, if the product $C_e \cdot C_f$ tends toward zero, then:

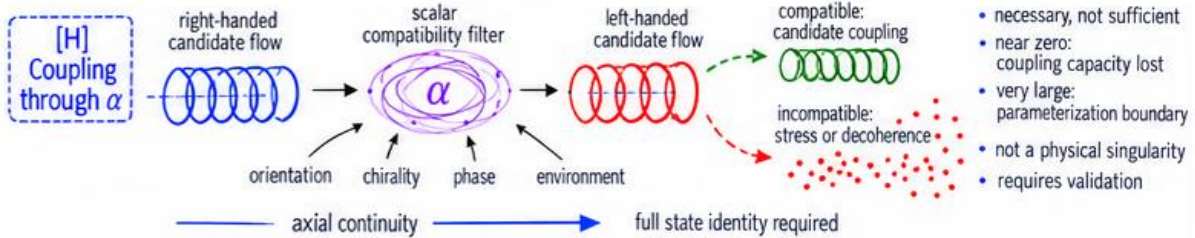
$$C_e \cdot C_f \rightarrow 0 \Rightarrow \alpha \rightarrow 0$$

This limit indicates the loss of the capacity for coherent coupling. The flow no longer preserves sufficient kinematic form or sufficient helical character to function as a coherent vortex tube.

Therefore, Σ_{gd} denotes here, with hypothetical status, departure from the domain of use of the relation α and the transition between two states. The formula identifies a mathematical limit of the descriptor; the physical mechanism of transition must be supplied separately.

This distinction prepares the next chapter. Interaction kernels must not be introduced before the internal state and the ratio α have been defined. We must first know what a flow is as a system. Only then can we analyze how two systems mesh.

Therefore, α belongs at the boundary between identity and interaction. If α is incompatible, coherent interaction does not occur or produces geometric stress. If α is compatible, the flows may enter a common regime, but the exact type of interaction depends on orientation, chirality, axis, relative position, and the internal triplet.



[H] Hypothesis of coupling through α

α is the derived dimensionless state number. The Unified Theory formulates two testable hypotheses: compatibility of α is necessary, but not sufficient, for coupling; and proximity to the limits $\alpha \rightarrow 0$ or $\alpha \rightarrow \infty$ signals departure from the domain of the parameterized state. Their confirmation requires quantitative predictions of interaction.

6.15. Conclusion — from internal state to kernels

This chapter introduced the formal level of the Unified Theory. After defining the system, moving from pattern to principle, analyzing the vortex, and establishing the topological invariants, it became necessary to define the internal state of coherent helical flow.

This state cannot be reduced to the visible form of the tube or to a single classical invariant. Vorticity, circulation, vorticity flux, and helicity remain fundamental, but they do not exhaust the kinematic identity of the flow. Therefore, the Unified Theory introduces the fundamental Preda constants: C_c , C_f and C_e .

C_c describes flow continuity through controlled variation in flow rate. C_f describes kinematic form through the relationship between radius and tangential rotation. C_e describes the rotational/cyclic component, expressed through the relationship between radius and rotation frequency. Complete helical

character is additionally given by η , axial direction, and chirality. Together, the three quantities form the triplet:

$$\mathbf{C}_P = (\mathbf{C}_c, \mathbf{C}_f, \mathbf{C}_e)$$

This triplet defines the kinematic identity of the coherent vortex tube. Individual variables may vary, but the system remains the same flow only if its fundamental relationships are conserved.

The state relation was formulated through the dimensionless number α :

$$\alpha = \frac{\mathbf{C}_e \cdot \mathbf{C}_f}{C_c^2}$$

or, equivalently, in two other simplified forms:

$$\alpha = \frac{4\pi^2 C_e^2}{C_c^2}$$

$$\alpha = \frac{C_f^2}{4\pi^2 C_c^2}$$

This relation is one of the central proposed formulations of the Unified Theory. α is not a fourth independent constant, but a derived pure number. It compresses the scalar information of the triplet but does not replace the signed values of $\mathbf{C}_c$, the orientation descriptors, or the dynamics required to determine interaction.

The condition of internal coherence may be written through conservation of the triplet:

$$\frac{d\mathbf{C}_P}{dt} = \mathbf{0}$$

and through conservation of the state ratio:

$$\frac{d\alpha}{dt} = 0$$

This formulation shows that the tube's geometry is an adaptive variable. The tube preserves its identity not through rigidity, but through conservation of the relationships between geometry and motion. If these relationships can be preserved, the flow remains coherent. If they can no longer be preserved, geometric stress, decoherence, and reconfiguration occur.

Established anchors in physics support the general direction of this construction. The Helmholtz and Kelvin theorems show the importance of the persistence of vortex tubes in ideal fluids. Helicity and topological hydrodynamics show that a flow may possess structural memory. Vortex stretching shows that radius and rotation influence one another. Flows with swirl show the importance of the axial-tangential ratio. Beltrami flows show that coherent states may exist through internal alignment of fields. Quantum vortices show that organized rotation may be linked to strict state conditions. None of these directly demonstrates the Preda constants, but together they provide a solid scientific context for them.

Finally, α was delimited as a derived dimensionless ratio and does not enter the state vector as an independent variable. Its scalar-filter function for coupling and its boundary-indicator function are hypotheses of the theory, not demonstrated consequences. The model must specify which observable depends additionally on α and what measurable deviation appears when the compatibility hypothesis is violated.

The next chapter must begin here. If a tube has an internal state reported through $\mathbf{C}_P$ and an independent state vector, while α is tested as a hypothetical scalar filter, then interactions between flows may be classified through kernels. These schematically describe how flows induce, align, branch, continue axially, or reorganize one another.

Thus, Chapter 6 completes the construction of internal identity and opens the analysis of external relationships. From this point onward, the Unified Theory discusses not only isolated vortex tubes, but systems of interacting flows.

[H] Proposition of the transition to interaction

The internal state of a coherent helical flow is reported through the Preda triplet, while $\alpha = (\mathbf{C}_e \cdot \mathbf{C}_f)/C_c^2$ is its derived dimensionless descriptor. The possible use of α as a scalar coupling filter is a testable hypothesis; interactions are then classified schematically through the kernels of the Unified Theory.

7. Interaction Kernels and the Minimal Formal Scheme of the Unified Theory

7.1. From the state relation to interaction

The preceding chapter established that a coherent helical flow is not defined solely by its visible form. A vortex tube may change its radius, pitch, cross-section, local rotational intensity, axis position, and distribution of constituent lines without immediately losing its identity. Identity resides not in the transient contour, but in the relationships that remain conserved during adaptation.

In the formulation of the Unified Theory, these relationships are synthesized through the fundamental Preda constants: C_c , C_f , and C_e . They describe variation in transport and the same rotational constraint through two measurement pathways. The axial component and complete helical character are described separately through η , direction, and chirality. Together, the Preda quantities form the operational triplet of coherent flow:

$$\mathbf{C}_P = (C_c, C_f, C_e)$$

However, a flow does not exist solely through itself. It enters into relationships with other flows, attractors, branches, toroidal structures, dynamic boundaries, and compatible regions for receiving transport. From this point onward, the problem is no longer merely internal identity, but the possibility of interaction.

The transition from internal identity to interaction is made through α . In this work, α is not introduced as a fourth independent constant added to C_c , C_f , and C_e . It is the state number resulting from the ratio of the three constants:

$$\alpha = \frac{C_e \cdot C_f}{C_c^2}$$

Written equivalently, the relation becomes:

$$\alpha \cdot C_c^2 = C_e \cdot C_f$$

This is the proposed dimensionless state relation for coherent helical flow. C_c , C_f and C_e are the input quantities, while α is the derived ratio. The relation classifies a state, but by itself does not describe its evolution or interaction.

α is a pure number without a unit of measurement. At this stage, it is a scalar descriptor of the state. Its use as a geometrodynamics compatibility parameter is a hypothesis: two candidate structures must have compatible values of α , but this compatibility alone does not determine the outcome.

The analogy with gears is useful, but must be kept within its limits. In mechanics, gear module is a geometric quantity. In the Unified Theory, α is a dimensionless state quantity. Its conceptual role is nevertheless similar: it establishes whether two systems can enter functional contact without mutually destroying their working geometry.

Under the coupling hypothesis, α functions as a preliminary scalar filter of interaction. Its compatibility permits only a transition to verification of dynamic and geometric conditions; incompatibility may be associated with stress or reconfiguration only if the model specifies the mechanism and thresholds producing these outcomes.

The three functions are logically separate. The certain function is that of the defined dimensionless ratio. The coupling function and the boundary-indicator function are working hypotheses. The chapter constructs the taxonomy of these hypotheses without presenting them as already derived laws.

The present chapter begins here. Whereas in Chapter 6 the flow was analyzed from within through its fundamental constants, in Chapter 7 it is analyzed from the outside through the ways in which this internal identity can enter into relationships with other identities. These modes are called fundamental interaction kernels.

[H] Hypothesis of transition through α

C_c , C_f and C_e report the internal identity of coherent helical flow, while α is their derived ratio. Under the proposed hypothesis, α may function only as a preliminary scalar filter of external coupling, not as a sufficient criterion.

7.2. The extended state of a helical flow

To describe the interaction between two flows, the operational triplet C_c, C_f, C_e is not sufficient. The comparison must be made using independent components: C_c , the rotational descriptor C_r , the ratio η , axial direction S , chirality χ , phase ϕ , and the functional region. The number α is calculated separately and may be tested as an auxiliary filter.

For this reason, it is useful in Chapter 7 to introduce the extended state of a helical flow. It may be denoted by:

$$\mathcal{S}\chi, \text{ind} = (C_c, C_r, \eta, S, \chi, \phi, \mathcal{R})$$

where C_r represents the independent rotational descriptor, η the axial–tangential ratio, S the axial direction, χ the chirality, ϕ the phase, and $\mathcal{R}$ the functional contact region: IN, path, or OUT. The vector does not replace the Preda triplet as a measurement set, but eliminates algebraic duplication from state comparisons.

For two flows i and j , the extended states are:

$$\mathcal{S}(i) = (C_c(i), C_r(i), \eta(i), S(i), \chi(i), \phi(i), \mathcal{R}(i))$$

$$\mathcal{S}(j) = (C_c(j), C_r(j), \eta(j), S(j), \chi(j), \phi(j), \mathcal{R}(j))$$

The interaction between these two flows does not depend solely on their spatial proximity. Two tubes may be very close and yet incompatible. Two flows may be separated by a transition region and yet be linked through coherent induction. What matters is the relationship between their extended states.

This observation is close to many situations known in physics. Two oscillators do not synchronize merely because they are close, but because their frequencies, phases, and coupling mechanism permit synchronization. Two wave modes do not interact efficiently merely because they occupy the same space, but because they satisfy matching conditions. Two vortices in a fluid may interact differently depending on orientation, intensity, sign, and distance.

In the Unified Theory, α concentrates state compatibility but does not exhaust it. Complete coupling must also account for axis, direction, chirality, and the functional region in which contact occurs. An OUT–IN interaction is not equivalent to IN–IN. Axial continuity is not equivalent to lateral alignment. Perpendicular induction is not equivalent to parallel replication.

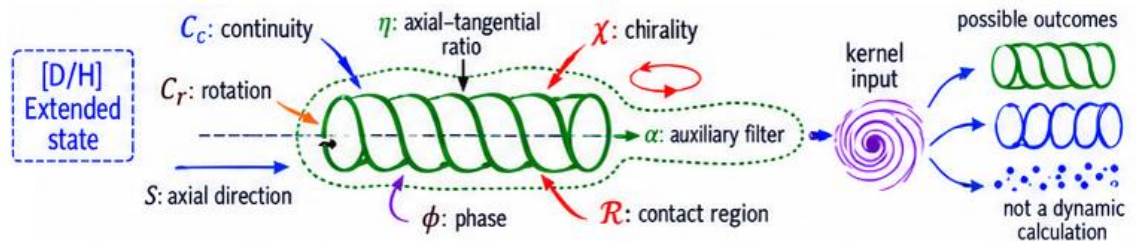
Therefore, the extended state is the conceptual input of the kernels. In its current form, the kernel classifies orientation, the assumed compatibility conditions, and the class of possible result. It does not yet calculate the amplitude, duration, or probability of the transformation.

In general form, this idea may be written as:

$$K(\mathcal{S}_i, \mathcal{S}_j, O_{ij}) \rightarrow \mathcal{S}'$$

where K is the interaction kernel, O_{ij} is the relative orientation between flows, and $\mathcal{S}'$ is the resulting state. The result is not necessarily a single flow. It may be an axial chain, a lateral bundle, a newly induced tube, a toroidal structure, a stress state, or decoherence.

This formulation separates two levels: the state relation classifies the interior of the flow, while the schematic kernel classifies the type of external relationship. The combination becomes rigorous only after the domain of each kernel, its parameters, evolution equations, and conservation criteria have been explicitly defined.



[H] Fundamental principle — the extended state of interaction

A helical flow enters into interaction through the independent state that includes C_c, C_r, η , axial direction, chirality, phase, and the functional contact region. C_f and C_e remain distinct measurement channels for C_r , while α remains a derived descriptor.

7.3. The compatibility hypothesis through α and the coupling threshold

Under the chapter's working hypothesis, the first scalar condition of interaction is compatibility through α . Two flows become candidates for coupling if their state numbers are equal or sufficiently close for the kernel involved; however, coupling stability does not follow from this condition alone.

A minimal measure of the coupling difference is:

$$\Delta\alpha_{ij} = |\alpha_i - \alpha_j|$$

Coupling is possible if the difference remains below an admissible threshold:

$$\Delta\alpha_{ij} \leq \varepsilon_\alpha$$

If the difference exceeds the threshold, the interaction is no longer coherent:

$$\Delta\alpha_{ij} > \varepsilon_\alpha$$

The threshold ε_α is not a universal constant. In its current form, it is a free parameter that must be estimated from data, simulations, or linear stability analysis for each kernel class. Without a calibration procedure, the inequality expresses only the structure of a testable condition, not a numerical prediction.

This distinction is important. Compatibility does not have the same severity in all kernels. When two flows must form an axial chain, their identity must be nearly complete. When two flows align laterally in a bundle, compatibility of α and compatibility of orientations may be sufficient. When a flow is generated by an attractor, α may be stabilized progressively rather than imposed in advance.

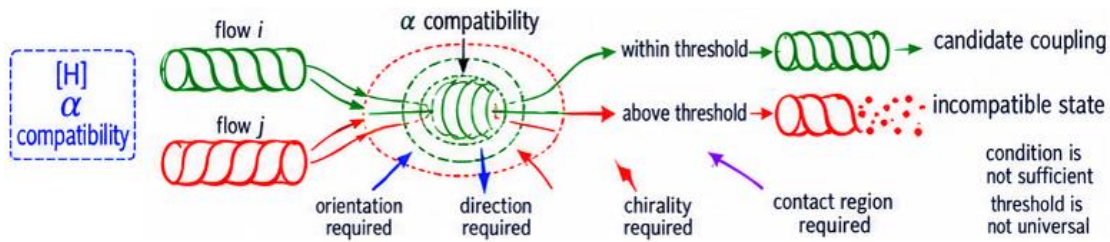
In general form, we may define a compatibility function:

$$C_\alpha(i, j) = \begin{cases} 1, & \Delta\alpha_{ij} \leq \varepsilon_\alpha \\ 0, & \Delta\alpha_{ij} > \varepsilon_\alpha \end{cases}$$

A value of 1 does not mean that the interaction has already occurred, but only that it is permitted from the standpoint of the state number. Geometric conditions are also required: orientation of the axes, axial direction, chirality, and the contact region.

Current physics provides numerous methodological analogies for such conditions. In quantum mechanics, transitions are not arbitrary but obey selection rules. In field theory, an interaction term has an effect only if the states and symmetries allow coupling. In oscillator dynamics, synchronization occurs only within a domain of compatibility. In vortex dynamics, orientation, the sign of circulation, and intensity influence approach, repulsion, or reconnection.

The Unified Theory does not directly identify α with these established quantities. The analogy justifies formulating a compatibility condition, not its exact form. The relationship among α , the threshold, and the outcome must be derived or measured for the hypothesis to become a law of interaction.



[H] Compatibility hypothesis through α

Under the proposed hypothesis, two flows become candidates for coupling only if the difference between their α numbers remains below the calibrated threshold of the kernel; satisfying the threshold does not guarantee coherent coupling.

7.4. Geometric stress and state incompatibility

When two flows interact, each may be forced to modify its geometry in order to adapt to the other. This modification may include the radius, pitch, axial velocity, tangential velocity, distribution of vortex lines, undulation of the axis, local chirality, or the position of the IN–OUT region.

If adaptation occurs without the independent components leaving their tolerances, the interaction may become coherent coupling. If adaptation exceeds the system's capacity to conserve C_c , the rotational descriptor C_r , and the orientation descriptors, geometric stress appears; the variation of α follows from these changes and does not constitute an independent loss.

Geometric stress is not ordinary mechanical stress. It expresses the difficulty a flow has in preserving its kinematic identity under the pressure of an interaction. In the simplest form, stress may be related to the state difference:

$$G_{ij} \sim \Delta\alpha_{ij}$$

For a more complete analysis, a state distance may be introduced:

$$\mathcal{D}(i, j) = w_c \cdot \delta c + w_r \cdot \delta r + w_\eta \cdot \delta \eta + w_\varphi \cdot \delta \varphi$$

where $\delta c = |C_c(i) - C_c(j)|/C_{c0}$, $\delta r = |C_r(i) - C_r(j)|/C_{r0}$, $\delta \eta = |\eta(i) - \eta(j)|/\eta_0$,
and $\delta \varphi = d(\varphi(i), \varphi(j))$ is the phase distance.

The coefficients w_c , w_r , w_η , and w_φ are analysis weights, while C_{c0} , C_{r0} , and η_0 are positive reference values. The formula remains a working scheme, not a final law; it no longer counts the rotational information or the derived ratio α twice. The weights and threshold must be calibrated from data. The continuous distance $\mathcal{D}$ is evaluated only after the discrete gate conditions for axial direction S , chirality χ , and contact region $\mathcal{R}$ are satisfied; otherwise the pair is classified as incompatible independently of $\mathcal{D}$.

Coherent coupling is possible when the state distance remains below a threshold:

$$\mathcal{D}_{ij} \leq \mathcal{D}_{cr}$$

If the threshold is exceeded, the system can no longer adapt its geometry locally without loss of identity:

$$\mathcal{D}_{ij} > \mathcal{D}_{cr} \Rightarrow \text{critical stress}$$

Critical stress does not automatically cause the absolute disappearance of the flow. It causes the loss of the former identity. This loss may result in several situations: repulsion, rupture, reconnection, reorientation, a change of kernel, or the emergence of a new coherent state.

This idea is central to the entire Unified Theory. Nature does not select rigid forms, but states capable of adaptation. A flow survives if it can modify its geometry without losing its state relation. When it can no longer do so, the old state dies as a state, even if matter or transport continues in another form.

[D] Criterion of geometric stress

Geometric stress appears when an interaction requires more adaptation than the flow can withstand without losing its state equation. Below the threshold, coupling occurs; above the threshold, decoherence or reconfiguration occurs.

7.5. The geometrodynamic kernel as a schematic interaction operator

To describe interactions between helical flows, the notion of a geometrodynamic kernel is required. The kernel is neither a separate material object nor a force in the classical sense. It is the minimal scheme through which two flow states enter into relationship.

In its current form, a kernel is defined as a schematic operator: it receives the labels of two extended states and their relative orientation, then classifies the admissible outcomes—coupling, induction, continuity, conversion, decoherence, or reconfiguration. The term “operator” does not yet imply the existence of an explicit dynamic function.

Formally:

$$K_X: (\mathcal{S}_i, \mathcal{S}_j, O_{ij}) \rightarrow R_X$$

where X indicates the kernel type, O_{ij} describes the relative orientation, and R_X is the result of the interaction. The result may be a new state:

$$R_X = \mathcal{S}'$$

or an ensemble of states:

$$R_X = \{\mathcal{S}'_1, \mathcal{S}'_2, \dots, \mathcal{S}'_n\}$$

or a state of decoherence:

$$R_X = \mathcal{D}$$

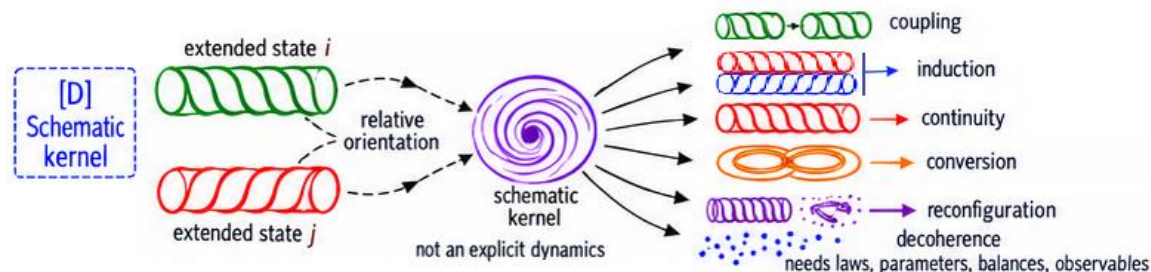
This notation must be read as a symbolic transformation rule. It goes beyond a simple geometric image, but remains a formal placeholder until each kernel is assigned an evolution law, parameters, initial and boundary conditions, conserved quantities, and a calculable result.

In current physics, the term “kernel” generally denotes an explicit mathematical object. The Unified Theory uses it in its own geometrodynamic sense, as the schematic core of the relationship between two flows. To avoid ambiguity, the kernels in this chapter are a taxonomy of proposed operators, not integration kernels or propagators that have already been calculated.

The kernel must satisfy three conditions:

1. indicate the type of orientation between flows;
2. indicate the required level of compatibility;
3. indicate the possible outcome of the interaction.

These three conditions make the classification conceptually unambiguous. A subsequent dynamic formalization must add dependence on time and distance, environmental parameters, balances of mass, momentum, and energy, as well as observables that distinguish one kernel from another.



[D] Definition of the kernel as a schematic operator

A geometrodynamical kernel is a minimal interaction descriptor, a schematic operator that classifies possible transformations between extended states. It becomes a complete physical operator only after an explicit dynamics and verifiable quantitative results have been specified.

7.6. Why four fundamental kernels are proposed

Within the Unified Theory, coherent helical interactions are proposed to be reduced to four kernels. The reduction begins from the selected minimal geometry—attractor, axial continuity, lateral proximity, and torus–cylinder conversion—and, at this stage, has the status of a classification hypothesis.

A helical tube has an axis, a periphery, an inlet region, a transport region, and an outlet region. It may encounter a capture region, another axial tube, another lateral tube, or a closed toroidal structure. These situations yield four primary types of relationship:

The kernels may be presented synthetically as follows:

C–A — cylinder–attractor relationship; axial orientation toward a potential difference; function of genesis, capture, and initiation.

M–C — multiple-cylinder relationship; end-to-end axial orientation; function of continuity, chain formation, and transmission.

C–C — cylinder–cylinder relationship; parallel lateral orientation; function of induction, replication, and bundle formation.

T–C — torus–cylinder relationship; perpendicular orientation; function of conversion, closure, and transverse induction.

These four kernels form the proposed Fundamental Code of helical interactions. They represent a minimal grammar of genesis, axial extension, lateral multiplication, and perpendicular conversion.

C–A classifies genesis, M–C axial continuity, C–C lateral growth, and T–C conversion between axial transport and closed circulation. The closure hypothesis states that more complex structures can be represented through their composition; the completeness of this list must be demonstrated on a defined configuration space or tested through counterexamples.

It must be specified that these kernels are not yet particles, forces, or fields in the sense of established physics. They are minimal geometrodynamical schemes. Only later can it be analyzed whether particular physical phenomena can be placed in correspondence with these schemes.

The Fundamental Code does not derive the known forces and does not yet demonstrate universal exhaustiveness. Its claim is narrower: within the domain of configurations selected by the model, each interaction will be tested as one of the four types, as a composition, or as a counterexample requiring extension of the taxonomy.

Relationships that appear additional may be reduced to these four forms. A torus–torus interaction is not treated as a separate fundamental kernel because, in the basic formulation, a torus does not directly induce another torus; it may be decomposed through torus–cylinder relationships or remain an incompatible interaction. An attractor–attractor relationship is not a transport kernel because attractors define potential differences, not axial flows of their own. A cylinder–environment relationship becomes

C–A if the environment functions as an attractor, C–C if it induces parallel tubes, or T–C if it generates transverse closure.

In this sense, the list is complete by construction within the selected minimal taxonomy, not yet by a theorem covering all possible physical interactions.

[H] Hypothesis of the Fundamental Code

In the proposed taxonomy, interactions of coherent helical flows are classified through four kernels: C–A, M–C, C–C, and T–C. They describe genesis, axial continuity, lateral multiplication, and perpendicular conversion; their completeness remains a falsifiable hypothesis.

7.7. The C–A kernel — genesis induction

The C–A kernel describes the relationship between a cylindrical flow and an attractor. The term “cylinder” denotes the idealized axial form of a coherent helical flow. The attractor denotes a region of potential difference that draws in and accumulates geometrodynamical mass, becoming a source for the organization of transport.

C–A is the kernel of genesis. It appears when a state difference produces not merely diffuse motion, but an oriented flow. The attractor imposes the direction of capture, and the flow begins to form its axis. At this stage, the tube is not yet stable as a mature system, but the initial condition of helical flow emerges.

The minimal condition of the C–A kernel is the existence of a functional gradient:

$$\nabla\Phi_{\mathcal{A}} \neq 0$$

where $\Phi_{\mathcal{A}}$ represents the potential associated with the attractor. When a potential difference exists, capture becomes possible:

$$K_{CA}(\mathcal{A}, \mathcal{S}_i) \rightarrow \mathcal{S}_{new}$$

In this relationship, $\mathcal{A}$ is the attractor, $\mathcal{S}_i$ is the state of the dispersed or incipient flow, and $\mathcal{S}_{new}$ is the state of the flow that begins to organize axially.

During the C–A stage, α must not be imagined as fully mature from the outset. The attractor may impose conditions that gradually lead toward stabilization of α :

$$\alpha(t) \rightarrow \alpha_0$$

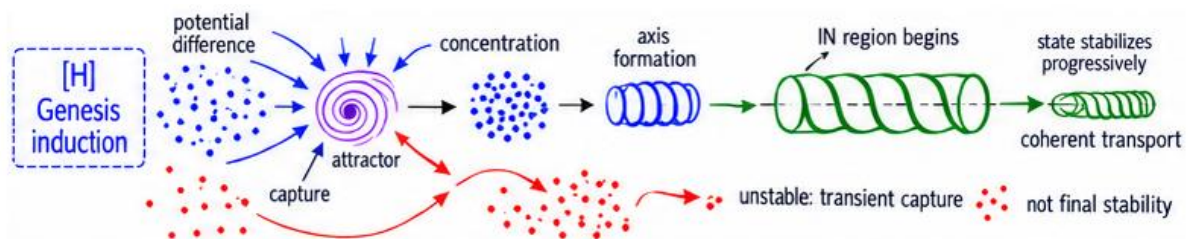
where α_0 is the stabilized state number of the newly formed flow. If this stabilization does not occur, C–A remains a transient capture. If it does occur, the flow may proceed toward the coherent transport region.

C–A has three stages:

1. *the emergence of a potential difference;*
2. *capture and concentration of the flow;*
3. *formation of the axis and stabilization of a helical state.*

In fluid mechanics, the simplest analogy is a drain vortex. An outlet or pressure difference may organize the fluid around an axis of capture. In astrophysics, a gravitational difference may concentrate matter around a region of accumulation. In open systems, any coherent input presupposes a mode of capture. These examples do not demonstrate the C–A kernel, but they show that genesis through a potential difference is a recognizable physical mechanism.

C–A is generally not the kernel of final stability. It opens the process. After genesis, the flow must stabilize by conserving the constants, enter a transport region, and define its possibilities of coupling with other states.



[H] Hypothesis of genesis induction

The C–A kernel appears when an attractor, defined by a potential difference, induces the formation of an axial flow. It initiates the IN region, forms the axis, and prepares the emergence of a coherent helical state.

7.8. The M–C kernel — axial continuity

The M–C kernel describes axial continuity between compatible flows. It is the kernel of the chain, end-to-end extension, and transmission of transport along the same functional direction. If C–A produces genesis, M–C produces continuity.

In M–C, two or more cylindrical flows align along the direction of the axis and form a longer transport structure. This relationship is stringent, because it is not sufficient for the tubes to have similar values of α . For strict axial continuity, the entire internal identity must be conserved:

$$(C_c, C_r, \eta, S, \chi, \varphi)[i] = (C_c, C_r, \eta, S, \chi, \varphi)[j]$$

In addition, the axes must be collinear or sufficiently close to collinearity:

$$\hat{a}_i \parallel \hat{a}_j$$

and the axial directions must permit continuity of transport:

$$s_i \rightarrow s_j$$

In this formulation, the arrow does not indicate abstract equality, but functional compatibility of transport. The OUT region of one flow can become the IN region of the next flow:

$$OUT_i \rightarrow IN_j$$

Then the M–C kernel may be written:

$$K_{MC}(\mathcal{S}_i, \mathcal{S}_j) \rightarrow \mathcal{S}_{chain}$$

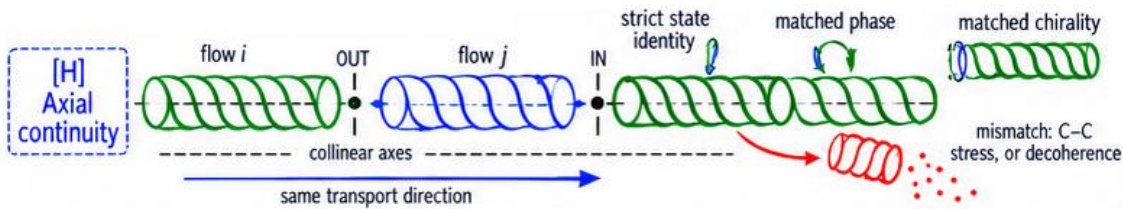
where $\mathcal{S}_{chain}$ is the state of the resulting axial chain. If the states are identical or perfectly compatible, the chain may conserve the same kinematic identity over a greater length:

$$\mathcal{S}_{chain} \equiv \mathcal{S}_i \equiv \mathcal{S}_j$$

This severity justifies the analogical association of M–C with a fermionic, monochiral regime within the Unified Theory. It is not claimed that M–C is a real fermion. The claim is that its logic resembles strict individuality: axial continuity requires identity of state, not merely weak compatibility.

Current physics provides useful analogies. In a chain of oscillations, coherent transmission requires mode matching. In a waveguide, stable propagation requires compatibility between mode and geometry. In vortex dynamics, filaments with compatible orientation and circulation may interact so as to transmit tension or undergo stretching. The Unified Theory uses these analogies only as conceptual support.

If identity is incomplete, M–C cannot be maintained. The interaction may shift to C–C if the axes are parallel and permit lateral alignment, or it may produce stress and decoherence. M–C is therefore the kernel of strict continuity, not of simple proximity.



[H] Proposition of axial continuity

The M–C kernel appears when two or more compatible helical flows form end-to-end continuity. Strict axial continuity requires the simultaneous conservation of C_c , C_f , C_e , and implicitly α .

7.9. The C–C kernel — lateral induction, replication, and the bundle

The C–C kernel describes the relationship between two flows whose axes are parallel or nearly parallel. Unlike M–C, C–C does not mean end-to-end extension. It means lateral proximity, parallel induction, replication, or aggregation into a bundle.

The minimal geometric condition is axial parallelism:

$$\hat{a}_i \parallel \hat{a}_j$$

The state condition may be weaker than in M–C. Complete identity of the Preda triplet is not mandatory for lateral coupling. Compatibility of α is nevertheless required:

$$|\alpha_i - \alpha_j| \leq \epsilon_\alpha$$

In simple form:

$$K_{CC}(\mathcal{S}_i, \mathcal{S}_j) \rightarrow \mathcal{S}_{bundle}$$

or, in the induction regime:

$$K_{cc}(\mathcal{S}_i, \emptyset) \rightarrow \mathcal{S}_j$$

The second formula expresses the idea of lateral replication: an existing flow may induce the emergence of a compatible neighboring flow if the environment and state differences allow it. This is not biological replication, but geometrodynamical replication: one flow state produces the conditions for the emergence of a related state. This mechanism might be found to underlie the replication of life.

C–C has two main functions.

The first function is aggregation. Several compatible flows may align laterally in a bundle:

$$\mathcal{S}_{bundle} = \mathcal{S}_1 \oplus_{lat} \mathcal{S}_2 \oplus_{lat} \dots \oplus_{lat} \mathcal{S}_n$$

The second function is the induction of new arms. A mature flow may generate lateral flows that partially inherit its coupling state:

$$\alpha_j \rightarrow \alpha_i$$

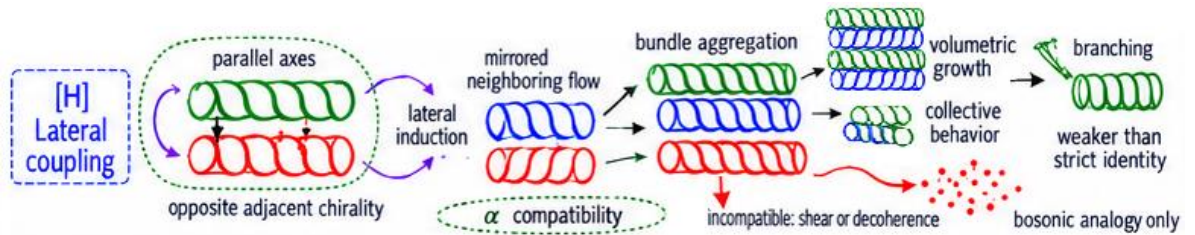
This relationship must not be read as perfect mechanical copying, but as a tendency toward compatibility. Lateral flows may have different values of the internal constants, but they must be able to operate within the same coupling regime.

Here the difference between M–C and C–C becomes apparent. In M–C, internal identity must be strict. In C–C, lateral compatibility may be more permissive. This allows volumetric growth, branching, and the formation of collective structures.

For this reason, within the Unified Theory, C–C may be associated analogically with a bosonic, bichiral regime—not by identification with the real bosons of the Standard Model, but because it permits aggregation, functional superposition, and collective behavior.

In current physics, analogies may be found in vortex beams, bundles of quantum vortices in superfluids, plasma filaments, or field structures that align. These examples do not demonstrate the C–C kernel, but they show that rotating structures can form coherent ensembles through lateral compatibility.

If α is not compatible, C–C does not produce a coherent bundle. The result may be shear, repulsion, instability, or a change in the interaction type. In the limiting case, decoherence occurs.



[H] Hypothesis of lateral induction, replication, or aggregation into a bundle

The C–C kernel appears between helical flows with parallel or nearly parallel axes. It permits aggregation into a bundle, lateral replication, and volumetric growth, provided that compatibility through α is satisfied. Adjacent chiralities are always opposite.

7.10. The T–C kernel — perpendicular induction and torus–cylinder conversion

The T–C kernel describes the relationship between a toroidal structure and a cylindrical flow. It is the most delicate of the kernels because it describes not the simple alignment of two axes, but conversion between axial transport and apparently closed circulation.

A cylinder expresses transport oriented along an axis. A torus expresses apparently closed circulation around a central region. There is a natural geometric relationship between them: the cylinder axis passes through the center of the toroidal plane, while toroidal circulation occurs in planes perpendicular to axial transport.

The basic geometric condition may be expressed as follows:

$$\hat{a}_c \parallel \hat{n}_T$$

where $\hat{a}_c$ is the cylinder axis, and $\hat{n}_T$ is the normal to the toroidal plane. This means that the plane of the torus is perpendicular to the cylinder axis.

At the same time, the local direction of toroidal circulation is perpendicular to the cylinder axis:

$$\hat{a}_c \perp \hat{t}_T$$

where $\hat{t}_T$ is the tangential direction of toroidal circulation.

[H] The fundamental T–C rule is that induction is perpendicular. A cylinder may induce tori around its axis:

$$K_{TC}(S_C) \rightarrow S_T$$

and a torus may condition the emergence of a cylinder through its planar center, as a C–T inverse:

$$K_{TC}(S_T) \rightarrow S_C$$

This relationship is not symmetric in a simple sense. A torus does not directly induce a fundamental torus. A torus–torus relationship is not introduced as a fifth kernel. If two toroidal structures enter into relationship, their interaction may be interpreted through induced cylinders, T–C sequences, or incompatibility:

$$K_{TT} \notin S_{TU}$$

or:

$$K_{TT} \Rightarrow K_{TC} \circ K_{TC} \quad \text{or} \quad \mathcal{D}$$

T–C is the kernel that links axial transport to the closed cycle. For this reason, it will become important in the chapters on space–time–cycle, Σ_{gd} , memory, and reconfiguration. The torus may preserve a circulation, the cylinder may transport a state, and T–C converts between the two regimes.

In current physics, analogies may be found in vortex rings, plasma tori, magnetohydrodynamic structures, toroidal flows, and modes with orbital angular momentum. It is not claimed that all these systems are identical to T–C. The claim is that nature already exhibits transitions among axial transport, closed circulation, and toroidal structures.

If T–C is compatible, the result may be transverse stabilization, cycle closure, transport conversion, or generation of a toroidal structure. If it is incompatible, rupture, dispersion, or decoherence may occur.



[H] Hypothesis of perpendicular induction

The T–C kernel expresses the proposed geometrodynamical conversion between axial transport and toroidal circulation. Induction is postulated to be perpendicular: the cylinder may induce a torus around its axis, while the torus may condition the emergence of a cylinder through its central region. Identity of adjacent chiralities is an internal testable rule of the model, not a demonstrated consequence for all systems.

7.11. Vertical, horizontal, and perpendicular interactions

The four kernels can be understood more clearly in relation to three functional directions: vertical, horizontal, and perpendicular.

Vertical interaction is axial interaction. It concerns continuity of transport along the axis. The dominant kernel is M–C. Strict identity of state and end-to-end continuity matter here. Vertical means transport, chain, extension, and axial persistence.

Horizontal interaction is lateral interaction. It concerns the alignment of neighboring flows, replication, the bundle, and volumetric growth. The dominant kernel is C–C. Compatibility of α and parallel orientation of the axes matter here. Horizontal means aggregation, lateral induction, branching, and emergence.

Perpendicular interaction is the conversion between axial and circular. Axial transport generates local transport perpendicular to the axis. The dominant kernel is T–C. The relationship between the cylinder axis and the plane of the torus matters here. Perpendicular is neither an axial chain nor a lateral bundle; it is a transformation of regime through direction and sense.

C–A has a special status. It is not purely vertical, horizontal, or perpendicular. It is the kernel of entry into structure, because the attractor creates the condition of genesis. C–A may initiate the axis, after which the flow may stabilize through M–C, multiply through C–C, or close/become transverse through T–C.

In synthetic form:

$$K_{CA} = \text{genesis}$$

$$\begin{aligned}
K_{MC} &= \text{vertical continuity} \\
K_{CC} &= \text{horizontal emergence} \\
K_{TC} &= \text{perpendicular conversion}
\end{aligned}$$

This division is essential for avoiding confusion. C–C does not extend end to end. M–C does not produce a lateral bundle. T–C is not a simple parallel branching. C–A is not a mature state of transport, but induction of genesis.

[H] In the proposed scheme, kernels may be composed: a flow could emerge through C–A, continue through M–C, induce parallel flows through C–C, and generate toroidal structures through T–C. This composition provides a candidate language for complex architectures. The four-kernel scheme remains a falsifiable completeness hypothesis: an irreducible configuration would mark a limit of the taxonomy, not create a fifth fundamental kernel.

[H] Proposition of interaction directions

M–C describes the axial vertical of continuity, C–C describes the lateral horizontal of emergence, T–C describes perpendicular conversion, and C–A describes genesis through an attractor.

7.12. The minimal formal scheme of the Unified Theory

At this point, the minimal symbolic scheme of the Unified Theory may be formulated. The relation E_α classifies the proposed internal identity, while the kernels classify the minimal modes of relationship. The scheme is a formalized conceptual core, not yet a closed system of differential equations.

The state relation is:

$$E_\alpha: \quad \alpha = \frac{C_e \cdot C_f}{C_c^2}$$

or:

$$E_\alpha: \quad \alpha C_c^2 = C_e \cdot C_f$$

This relation defines the internal state of coherence. It states that the vortex tube is not merely a form, but a state closed through the ratio among C_c , C_f , and C_e .

The fundamental kernels are:

$$\begin{aligned}
K_{CA}: (\mathcal{A}, \mathcal{S}) &\rightarrow \mathcal{S}_{new} \\
K_{MC}: (\mathcal{S}_i, \mathcal{S}_j) &\rightarrow \mathcal{S}_{chain} \\
K_{CC}: (\mathcal{S}_i, \mathcal{S}_j) &\rightarrow \mathcal{S}_{bundle} \quad \text{or} \quad \mathcal{S}_j \\
K_{TC}: (\mathcal{S}_C, \mathcal{S}_T) &\rightarrow \mathcal{S}_C' \quad \text{or} \quad \mathcal{S}_T'
\end{aligned}$$

Together, the state relation and the symbolic rules of the kernels form the minimal formal scheme of the Unified Theory:

$$\mathcal{S}_{TU} = \{E_\alpha, K_{CA}, K_{MC}, K_{CC}, K_{TC}\}$$

This is the proposed central formulation of the chapter. $\mathcal{S}_{TU}$ brings together a dimensionless relation and four classes of transformations. The notation organizes the theory, but its elements do not yet have the same mathematical status: E_α is an algebraic definition, while the kernels are schematic rules.

The state relation describes the internal parameters, while the kernels inventory the classes of interaction. Together they provide a grammar of flow networks. To become a predictive system, each rule must be transformed into an explicit mapping that conserves or transfers defined quantities and produces numerical results.

From this perspective, the Unified Theory has a formal epicenter of principles:

$$\text{internal identity} + \text{external interaction} = \text{complete geometrodynamic system}$$

or:

$$E_\alpha + \{K\} = \text{core of the Unified Theory}$$

The comparison with equations of state, field equations, and interaction terms is methodological. E_α is not yet a field equation, and the kernels are not yet explicit dynamic terms. The theory proposes this architecture as a program of formalization for coherent helical flows.

[D] Definition of the minimal formal scheme

The relation E_α and the C–A, M–C, C–C, and T–C kernels constitute the proposed minimal formal scheme. It organizes identity and interaction, but will become a system of physical equations only after the dynamics of each kernel have been made explicit.

7.13. Rules for composing kernels

The kernels do not always act in isolation. In real systems, a flow may pass through a succession of kernels. This succession forms the geometrodynamic biography of a state: emergence, stabilization, growth, conversion, stress, decoherence, and reconfiguration.

An elementary sequence may be:

$$K_{CA} \rightarrow K_{MC} \rightarrow K_{CC} \rightarrow K_{TC}$$

This is not a mandatory order for all systems, but one possible scheme. C–A produces genesis. M–C permits axial continuity. C–C permits lateral growth and bundle formation. T–C permits closure, conversion, or the emergence of the transverse cycle.

In other situations, C–C may precede M–C. For example, a lateral bundle may emerge before axial chains have fully stabilized. In other situations, T–C may appear as a response to stress, transforming an axial flow into a partial toroidal structure.

The composition of kernels may be denoted:

$$K_Y \circ K_X(\mathcal{S}_i, \mathcal{S}_j) \rightarrow \mathcal{S}''$$

where K_X produces an intermediate state, and K_Y acts upon it. This notation shows that a complex structure does not require new rules, but compositions of the fundamental kernels.

There are three main outcomes of composition.

The first is stabilization:

$$K_{MC} \circ K_{CA} \rightarrow \mathcal{S}_{coherent}$$

Here, a flow born through an attractor becomes coherent axial transport.

The second is growth:

$$K_{CC} \circ K_{MC} \rightarrow \mathcal{S}_{network}$$

Here, an axially stable flow induces lateral flows and forms bundles or networks.

The third is reconfiguration:

$$K_{TC} \circ K_{CC} \rightarrow \mathcal{S}_{cyclic}$$

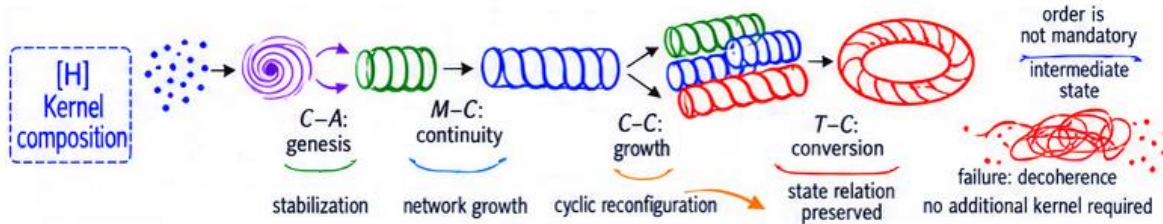
Here, a lateral structure may produce closure, circulation, or toroidal conversion.

If no kernel can conserve E_α , the result is decoherence:

$$\forall K_X, \quad K_X(\mathcal{S}_i, \mathcal{S}_j) \not\models E_\alpha \Rightarrow \mathcal{D}$$

This formula states that if no mode of interaction can preserve the state relation, the old flow can no longer survive as a coherent identity.

The composition of kernels prepares the following chapters. Memory, information, geometrodynamic Darwinism, kinematic correlation, and the Σ_{gd} regime are not themes separate from kernels. They appear when kernels are composed, fail, repeat, or force the reconfiguration of a state.



[H] Proposition of the composition of kernels

Complex structures of helical flows do not require additional kernels. They may be described through sequences and compositions of the C–A, M–C, C–C, and T–C kernels, under the constraint of the state relation E_α .

7.14. The Fundamental Code and the proposed domain of closure

For the taxonomy to be testable, every new interaction must be tested as an instance of a kernel, a composition, an incompatible regime, or a counterexample. The last possibility is essential: a valid counterexample would show that the list of four kernels is not closed.

A cylindrical flow in contact with an attractor enters C–A. This is the interaction of capture and genesis.

Two cylindrical flows with collinear axes and end-to-end continuity enter M–C. This is the axial-chain interaction.

Two cylindrical flows with parallel axes, placed laterally, enter C–C. This is the interaction of bundling, replication, or lateral induction.

A cylindrical flow and a toroidal structure, oriented perpendicularly, enter T–C. This is the torus–cylinder conversion interaction.

[H] In the proposed minimal taxonomy, two tori interact without defining a fifth fundamental kernel. If their dynamic model can be decomposed into induced cylinders or T–C sequences, the interaction is classified accordingly; if the data reveal irreducible dynamics, the claimed completeness of the four-kernel taxonomy is falsified and the configuration remains outside its present domain. Reduction to T–C is therefore a classification hypothesis, not a theorem.

An attractor with another attractor does not form a flow kernel. Attractors may organize the potential field, but a kernel appears only when an induced flow exists. Thus, attractor–attractor prepares conditions but is not a complete helical interaction.

A flow interacting with an environmental boundary may be reduced according to its effect. If the boundary captures, the relationship is C–A. If it induces parallel tubes, it is C–C. If it generates transverse circulation, it is T–C. If it merely slows and breaks the structure, the result is stress and decoherence.

A branch (root) with its trunk may be M–C if it continues axially, C–C if it develops laterally, T–C if it induces perpendicular circulation, or a combination of kernels if it participates in a more complex network.

In synthetic form:

$$\text{possible interaction} = K_X \quad \text{or} \quad K_Y \circ K_X \quad \text{or} \quad \mathcal{D}$$

where $K_X, K_Y \in \{K_{CA}, K_{MC}, K_{CC}, K_{TC}\}$, while $\mathcal{D}$ represents decoherence.

This formalization preserves the economy of the code but remains open to falsification. A new configuration must be analyzed as genesis, axial continuity, lateral induction, perpendicular conversion, composition, decoherence, or a reproducible counterexample.

Closure hypothesis of the Fundamental Code

The closure hypothesis states that every interaction within the model's domain is expressed through a kernel, a composition, or decoherence. The need for a fifth type, demonstrated by a stable counterexample that cannot be recovered through composition, would falsify the current form of the Fundamental Code.

7.15. Methodological links with current physics

The kernels of the Unified Theory are not presented as formulas already accepted in current physics. They are original geometrodynamical proposals. Nevertheless, they can be linked methodologically to several established ideas.

The first direction is inevitably fluid mechanics. Vortex tubes, circulation, vorticity, reconnection, vortex rings, and interactions between filaments show that organized rotation can produce persistent structures and coupling relationships. C–A recalls the genesis of drain vortices and flows toward low-pressure regions. M–C recalls filament continuity. C–C recalls lateral interactions between vortex tubes. T–C recalls vortex rings and toroidal structures.

The second direction is topological hydrodynamics. Helicity shows that linking, twisting, and writhing of vortex lines can function as structural memory. The kernels extend this idea from topological memory toward geometrodynamical interaction. They do not replace helicity, but describe how states with memory enter into relationship.

The third path is the physics of coupled systems. Oscillators, waves, circuits, and normal modes interact effectively only when compatibility exists. The Unified Theory tests whether α can function as a scalar tuning filter. It is not a frequency and does not by itself determine compatibility between states.

The fourth path is field theory. In current physics, interactions are formulated through coupling terms, operators, symmetries, and selection rules. The kernels are not Lagrangian terms, but have a similar conceptual function: they indicate which interactions are permitted and what results they may produce.

The fifth direction is the physics of quantum vortices and topological structures. In superfluids and condensates, vortices may have quantized circulation, filamentary organization, and bundles. In topological systems, states may be protected by global properties.

These facts do not demonstrate the Fundamental Code, but they show that current physics already recognizes the importance of vortical, topological structures and state compatibilities.

The analogy with thermodynamic equations of state is limited. In thermodynamics, the relation is supported by measurable variables and an experimental domain. In the Unified Theory, E_α is currently a proposed dimensionless relation; its physical status depends on identifying a data domain in which α correlates with stability or interaction.

These links must be used cautiously. They are not final proofs, but bridges of intelligibility. Their purpose is to show that the Unified Theory does not begin in a conceptual vacuum, but extends directions already present in physics: states, invariants, couplings, selection rules, topology, vortices, and interactions through structure.

Statement of cautious anchoring

The kernels of the Unified Theory are not taken directly from current physics, but have methodological analogies in fluid mechanics, topological hydrodynamics, the theory of coupled systems, field theory, and the physics of quantum vortices.

7.16. The transient Σ_{gd} regime as a limit of the formal scheme

The transient Σ_{gd} regime is not introduced as a fifth kernel. In the proposed scheme, it denotes departure from the domain of a state and the transition interval in which no kernel has yet stabilized a new state. This delimitation is a hypothetical interpretation, not a sufficient consequence of the divergence of α .

From the state relation:

$$\alpha = \frac{C_e \cdot C_f}{C_e^2}$$

it follows that critical limits appear when the internal ratio becomes extreme. If C_e tends toward zero, with C_e and C_f nonzero, then:

$$C_e \rightarrow 0 \Rightarrow \alpha \rightarrow \infty$$

If the product $C_e \cdot C_f$ tends toward zero, with C_e nonzero, then:

$$C_e \cdot C_f \rightarrow 0 \Rightarrow \alpha \rightarrow 0$$

These limits first show that the parameterization through α approaches zero or diverges. Their interpretation as a critical geometrodynamical regime must be supported by finite physical variables, regularization, and a law describing the loss of stability.

If no kernel can restore compatibility, the transition occurs:

$$E_\alpha + \{K\} \rightarrow S_{\text{coherent}} \Rightarrow \Sigma_{gd}$$

where Σ_{gd} denotes the geometrodynamical transition regime. This regime is not necessarily an infinite physical point. It is a transition interval in which the old state is no longer coherent and the new state has not yet stabilized.

In this sense, the Σ_{gd} regime has a geometrodynamical duration, representing the critical interval between two coherent states:

$$S_{\text{old}} \rightarrow \Sigma_{gd} \rightarrow S_{\text{new}}$$

This formulation is important because it shifts the description from the category of an “impossible point” to that of a transition process. It is not a separate object, but the limit of the minimal formal scheme.

In current physics, singularities and divergences have distinct technical meanings. The Unified Theory does not resolve them merely by reinterpreting α . It proposes, as a research program, testing whether some descriptive limits can be regularized through an explicit geometrodynamical transition state.

[H] Hypothesis of the geometrodynamical transition regime Σ_{gd}

Under the geometrodynamical hypothesis, Σ_{gd} is not a kernel, but a transition interval between two states. The divergence of α signals only the limit of the parameterization; the existence and dynamics of the Σ_{gd} interval must be demonstrated separately.

7.17. Conclusion — the proposed formal core of the Unified Theory

Chapter 7 establishes the proposed formal core of the Unified Theory. The previous chapter defined the triplet C_c , C_f , C_e , and the derived ratio α . The present chapter organizes the interaction hypotheses into a taxonomy of four kernels.

The state relation is:

$$E_\alpha: \quad \alpha = \frac{C_e \cdot C_f}{C_c^2}$$

The fundamental kernels are:

$$K_{CA}, \quad K_{MC}, \quad K_{CC}, \quad K_{TC}$$

Together, they form the proposed minimal formal scheme:

$$\mathcal{S}_{TU} = \{E_\alpha, K_{CA}, K_{MC}, K_{CC}, K_{TC}\}$$

This formulation raises the theory from image to formal scheme: helical flow is described through proposed quantities, a dimensionless ratio, and symbolic rules of interaction. The transition to a predictive physical theory still requires explicit dynamics and experimental validation.

Within this framework, the Universe is viewed not as a collection of isolated objects, but as a network of geometrodynamical states. A state may emerge through C–A, continue axially through M–C, multiply laterally through C–C, convert perpendicularly through T–C, enter stress, undergo decoherence, or reconfigure.

Here the path toward the following chapters opens. If E_α and the kernels define state and interaction, the next question is what is preserved over time. The answer will require a chapter devoted to geometrodynamical memory and information: *the vortex has memory through conservation of the constants and information through the values of those constants.*

[D] Definition of the proposed formal core

The proposed formal core brings together the state relation E_α and the four kernels. The relation describes a derived dimensionless invariant, while the kernels classify possibilities of relationship and transformation; none is yet presented as a demonstrated complete dynamics.

8. Memory and geometrodynamical information

8.1. From kernels to the problem of memory

The previous chapter established the proposed minimal formal scheme: the dimensionless state relation and the four interaction kernels. The relation α compresses the Preda triplet into a scalar, while the kernels classify the minimal modes through which two helical flows can enter into relationship; their dynamics remain to be made explicit.

Through this construction, helical flow is no longer merely a form of motion. It becomes a state system. It has its own constants, compatibility criteria, modes of interaction, and it may pass through adaptation, decoherence, or reconfiguration. At this point an inevitable question arises: what does the system preserve when it transforms?

If a vortex tube modifies its radius, pitch, curvature, internal distribution of lines, axial velocity, or tangential velocity, yet remains coherent, then something must be conserved. This conservation is not merely a mathematical property. It is the way the system preserves its identity. In the geometrodynamical sense, this preservation of identity is memory.

Memory therefore must not be introduced as a psychological, biological, or computational property. Before all these specialized forms, memory may be understood as persistence of state in a system undergoing transformation. A system has memory when it is not completely erased by its own evolution, but preserves something recognizable from its previous state.

In the case of a vortex tube, this persistence is not tied to retaining the same matter. Matter may enter and leave. Filaments may redistribute rotation. Branches or roots may appear or disappear. The visible form may adapt. Nevertheless, if the fundamental values remain within the limits of coherence, the system remains the same flow. *Memory resides not in the material, but in the conserved state of the flow.*

This idea permits a central distinction for the Unified Theory: the vortex has memory through preservation of the constants and information through the values of those constants. A constant, as a type of conserved quantity, shows what can be preserved. The value of the constant shows what is preserved in the specific case of the system. Without conservation there is no memory. Without value there is no information.

We may formulate this distinction in its simplest form:

- **memory = preservation of constants**
- **information = values of constants**

This is the transition from geometry to state. A spiral, a helix, or a tube may be regarded as images. But only when it is possible to state what is conserved and what values are preserved does the system become a bearer of memory and information.

[H] Proposition of the transition from kernel to memory

A coherent helical flow is defined not only by its form and interactions, but by its capacity to preserve its state during transformation. This preservation is the system's geometrodynamical memory.

8.2. What memory means in a flow system

In ordinary language, memory is associated with the brain, digital information, writing, DNA, or material archives. All these forms are real, but may be regarded as specialized levels of a more general principle: the preservation over time of a relevant difference through sufficiently stable states and a mechanism for reading them.

A system has no memory if every transformation makes it completely different from any other variation of itself. *To have memory, it must preserve a state imprint.* This imprint need not be directly visible, but it must influence subsequent evolution. *Memory is therefore conservation with an effect.*

In a rigid object, memory seems simple. Form is preserved, composition is preserved, and the relative position of components is preserved. In a flow system, the situation is subtler. The form is not fixed, the matter is not the same, and the boundaries are not walls. Nevertheless, the system may preserve a functional state.

A river has memory through its bed, course, and flow regime. An atmosphere has memory through persistent circulations, pressure regions, dominant currents, and recurring structures. An organism has memory through the metabolic, genetic, and structural organization that permits continuity of function. In each case, memory is not a mere snapshot of the past, but an active constraint on the future.

In a coherent vortex tube, memory is given by the quantities that remain stable during adaptation. If the system can modify its variables without losing its fundamental relationships, then it remembers its own state. If these relationships are lost, memory is broken.

For this reason, flow memory differs from passive storage. It does not remain in one place, like an inscription on a surface. It is maintained through the dynamics itself. The tube preserves its memory only through flow, adaptation, and maintenance of coherence. Stopping the process does not preserve the vortex's memory; on the contrary, it destroys it.

In the Unified Theory, geometrodynamical memory has three levels:

1. **topological memory**, given by the way vortex lines are linked, twisted, and writhed;
2. **kinematic memory**, given by conservation of the Preda constants C_c , C_f , and C_e ;
3. **coupling memory**, given by the dimensionless number α and interaction compatibility.

These levels do not exclude one another. They describe the same structure from different perspectives. Topology preserves the mode of linking. Kinematics preserves the internal transport regime. Coupling preserves the possibility of relationship with other flows.

We may write synthetically:

$$M_{GMD} = \{M_{top}, M_{cin}, M_{cpl}\}$$

where M_{GMD} is the total geometrodynamical memory, M_{top} the topological memory, M_{cin} the kinematic memory, and M_{cpl} the coupling memory.

This formulation shows that the memory of a vortex is not a single parameter. It is an ensemble of conserved properties. The more levels of memory are preserved, the more coherent and stable the system is.

[H] Proposition of active memory

The memory of a flow system is not passive storage, but active conservation of a parameterized state. A coherent vortex preserves its memory only by maintaining its internal relationships during flow and adaptation.

8.3. Topological memory and geometrodynamic memory

The chapter on vortex-tube invariants showed that helicity provides the first rigorous language of structural memory. It measures not only rotation, but also the way vortex lines are linked, twisted, and writhed. Through helicity, a tube is no longer a simple column of fluid, but a structure with internal organization.

In topological hydrodynamics, the self-helicity of a tube must be distinguished from the mutual helicity between distinct tubes. For a single thin, closed tube: [8,9]

$$H \approx \Gamma^2 (T_w + W_r)$$

In this formulation, H expresses helicity, Γ circulation, T_w internal twist, and W_r writhing of the axis; the sum $T_w + W_r$ is the self-linking number of the tube. For two or more distinct tubes, the mutual linking L_k enters separately into the total helicity through terms weighted by the circulations of the tubes involved. The relation is used here as a conceptual anchor, not as a universal formula for every real vortex.

Topological memory does not, however, exhaust the entire identity of the flow. Two structures may have similar topological organization but different transport regimes. They may have the same type of linking, but a different flow rate, a different axial–tangential ratio, a different coupling mode, and a different capacity for adaptation. For this reason, the Unified Theory introduces geometrodynamic memory.

Topological memory answers the question:

how is the flow linked?

The geometrodynamic memory answers the question:

how does it remain the same flow during transport?

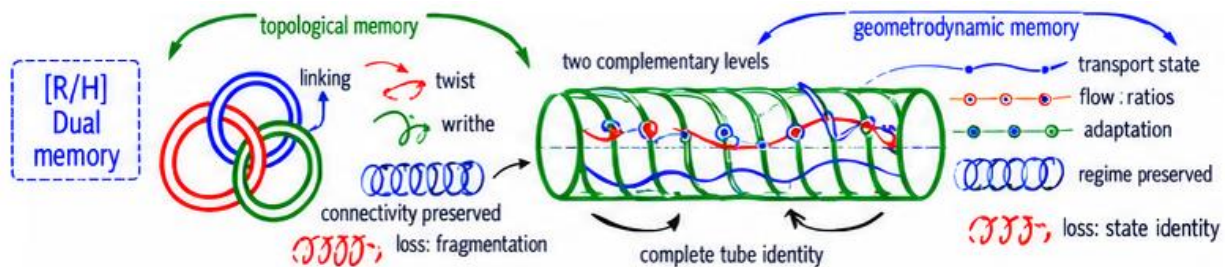
The first question concerns connectivity. The second concerns the internal state of transport. Both are necessary for a coherent vortex tube. A system without topological memory fragments structurally. A system without geometrodynamic memory loses its internal flow regime.

The complete memory of the tube must therefore be written as a superposition of two levels:

$$M_{tube} = M_{top} + M_{GMD}$$

This notation must not be understood as a simple numerical sum, but as a conceptual unification. The tube preserves memory through topology and state. Topology preserves internal linking, while geometrodynamics preserves the flow ratios.

This distinction is important for the following chapters. Geometrodynamics Darwinism selects not merely topological forms, but states capable of conserving both internal linking and the kinematic ratio of transport. A structure survives not simply because it has a beautiful or stable form, but because it can preserve active memory under variable environmental conditions.



[H] Proposition of the dual level of memory

The coherent vortex tube has topological memory through the organization of its lines and geometrodynamic memory through conservation of its transport state. Complete identity emerges only through the superposition of these two levels.

8.4. The Preda constants as the support of geometrodynamical memory

The Preda constants were introduced to describe the internal state of coherent helical flow. They are neither simple labels nor decorative parameters. They are the quantities through which the system preserves its kinematic identity when its geometry changes.

The fundamental triplet is:

$$\mathbf{C}_P = (C_c, C_f, C_e)$$

C_c describes the variation of transport, while C_f and C_e describe the same rotational constraint through tangential velocity and frequency. Together, they form the operational set that must be verified when local variables adjust.

In the coherent regime, the fundamental condition is:

$$\frac{d\mathbf{C}_P}{dt} = \mathbf{0}$$

or, explicitly:

$$\frac{dC_c}{dt} = 0, \quad \frac{dC_f}{dt} = 0, \quad \frac{dC_e}{dt} = 0$$

This relation is the formal expression of kinematic memory. It states that the system may transform, but cannot lose its triplet without losing its identity. The radius may change. The helical pitch may change. Velocities may adjust. But the triplet must remain conserved within the limits of coherence.

Memory is therefore not an addition to the constants. The constants are the support of memory. If they are not preserved, the system can no longer be recognized as the same flow. If they are preserved, the system may undergo significant deformation without dying geometrodynamically.

We may write:

$$\mathbf{M}_{cin} \equiv \left(\frac{dC_c}{dt} = 0, \frac{dC_f}{dt} = 0, \frac{dC_e}{dt} = 0 \right)$$

This relation does not assert that all variables are constant. On the contrary, the variables are free to adapt. What is conserved are the fundamental relationships among them. In a living system, molecules change, but functional organization is maintained. In a coherent vortex, the flow elements change, but the state triplet is preserved.

Here one of the most important ideas of the Unified Theory appears: identity is not rigidity, but adaptive conservation. The system remains the same not because it does not change, but because it knows how to change without losing its constants.

[H] Proposition of the constants as memory support

The Preda constants represent the support of geometrodynamical memory. A coherent vortex tube preserves its kinematic identity when C_c , C_f , and C_e are conserved during geometric adaptation.

8.5. The values of the constants as information

If preservation of the constants is memory, the values of those constants are information. This distinction is essential. It is not enough to say that a system conserves C_c , C_f , and C_e . We must also know the values of these constants, because it is precisely their values that distinguish one vortex from another.

Two flows may have the same type of memory but different information. Both may conserve a Preda triplet, but the values of the triplet may be distinct. In this situation, the two flows belong to the same general framework, but not to the same particular state.

We may denote the geometrodynamical information of a tube by the vector:

$$\mathbf{I}_{GD} = (C_c, C_r, \eta, S, \chi, \varphi)$$

where S represents the axial direction, χ the chirality, and φ the phase. The information also includes topological data:

$$\mathbf{I}_{ext} = (C_c, C_r, \eta, S, \chi, \varphi, H, L_k, T_w, W_r)$$

This is the extended information of the tube: not only the kinematic state, but also topological memory. It describes not only how the tube flows, but also how the flow is internally linked.

Information must not be confused with the symbol that represents it. The values are measurable physical differences. Under the theory's hypothesis, the independent vector $(C_c, C_r, \eta, S, \chi, \varphi)$ constrains the tube's response to deformations and interactions. C_f and C_e are reported as two measurement pathways for C_r , while α is calculated separately as a derived diagnostic.

In this sense, information is operational. It not only describes the system's past, but constrains its future. An informational state permits certain interactions and forbids others. It permits certain kernels and blocks others. It favors certain adaptations and makes others impossible.

We may write the condition of informational preservation as follows:

$$I_{GD}(t_1) = I_{GD}(t_2)$$

This equality does not mean that all geometric details are identical. It means that state information has been conserved between two moments. *The tube may look different, but if its state information remains the same, it remains the same flow.*

When the values change beyond the coherence threshold, the old information is lost. The system does not simply continue, but passes into another state. New information emerges, associated with a new set of constants.

$$I_{GD}^{old} \rightarrow I_{GD}^{new}$$

This transition will become essential in the next chapter, devoted to geometrodynamics Darwinism. Evolution means not only deformation, but transformation of state information under the pressure of the environment and interactions.

[H] Proposition of informational value

Memory is the capacity to conserve constants, while information is given by the specific values of those constants. Two vortices may have the same type of memory but different information if their state values differ.

8.6. α as a scalar descriptor and compatibility hypothesis

The state relation of coherent helical flow was formulated through the dimensionless number α :

$$\alpha = \frac{C_e \cdot C_f}{C_c^2}$$

written equivalently:

$$\alpha C_c^2 = C_e \cdot C_f$$

This relation has a precise role. C_c , C_f , and C_e form the operational triplet, while α expresses their derived ratio. It is neither length, velocity, nor force, and introduces no new degree of freedom. At this stage, it is a pure number; its role as an indicator of compatibility is a working hypothesis.

The analogy with the module of gears motivates a hypothesis; it does not demonstrate one: proximity of α values could select candidates within the same scalar regime. Stable coupling additionally requires relative geometry, direction, chirality, phase, distance, and explicit dynamics.

Under the idealized hypothesis of lateral coupling, the preliminary scalar filter is:

$$\alpha_i = \alpha_j$$

The condition neither establishes identity nor guarantees coupling. It selects only candidates with the same α number in the idealized model; participation in the same bundle must be determined through the independent state vector and the dynamics of the kernel.

For strict axial continuity, the condition is stronger:

$$(C_e, C_r, \eta, S, \chi, \phi)[i] = (C_e, C_r, \eta, S, \chi, \phi)[j]$$

This condition is necessary for coherent end-to-end chains, because external compatibility is insufficient there. The flows must continue the same internal identity.

Therefore, α may be treated as auxiliary compatibility information only within the hypothesis. It does not state whether two tubes will couple; at most, it permits testing a scalar filter before the independent conditions of interaction.

If the triplet is conserved, α is conserved automatically; this does not demonstrate preservation of an independent compatibility criterion. A variation in α signals a change in at least one component from which it is calculated. The consequence for coupling must be established experimentally for each kernel.

The condition of coupling memory may be written:

$$\frac{d\alpha}{dt} = 0$$

and the practical condition of coherence:

$$|\Delta\alpha| \leq \varepsilon_\alpha$$

where ε_α represents the system's compatibility tolerance.

[H] Hypothesis of α as a scalar filter

α is the derived dimensionless state number. The hypothesis is formulated that proximity of its values may function as a preliminary scalar filter: states that pass the filter remain only candidates for coupling, while associating incompatibility with stress or decoherence requires a dynamic mechanism and calibrated thresholds.

8.7. Axial direction and chirality as oriented information

The constants and the number α describe the internal state and compatibility of the flow, but do not exhaust the information of the vortex. A helical flow always has orientation. It has an axial direction and chirality. Without these two elements, the state information would be incomplete.

The axial direction, denoted by S , indicates the functional direction of transport. It permits differentiation among IN, path, and OUT. A helix without an axial direction is only a geometric form. A helical flow has a working direction: it captures, transports, and conducts.

Chirality, denoted by χ , indicates the mode of winding relative to the axial direction. It may be represented through discrete values:

$$\chi \in \{-1, +1\}$$

This notation does not reduce the phenomenon to a simple mathematical sign, but expresses the fact that a helical flow has two possible fundamental orientations. Chirality cannot be correctly established without the axial direction. The same apparent rotation may be misinterpreted if the direction of transport is not fixed.

The oriented information of a tube may therefore be denoted:

$$\mathbf{O} = (S, \chi)$$

and the complete geometrodynamic information becomes:

$$\mathbf{I}_{GD} = (C_c, C_r, \eta, \mathbf{O}, \varphi)$$

or:

$$\mathbf{I}_{GD} = (C_c, C_r, \eta, S, \chi, \varphi)$$

This oriented information becomes decisive in interactions. Two tubes may have similar values of the constants but incompatible axial directions. They may have the same α but chiralities that produce different coupling. They may form lateral bundles but not axial chains. They may participate in the induction of tori or block the mechanism, depending on orientation.

Chirality is an important concept in chemistry, biology, particle physics, and optics. The Unified Theory does not reduce these fields to a single simple mechanism, but uses the same general lesson: orientation is not a decorative detail. It can determine the system's compatibility and evolution. It may also be observed that the notions of spin up and spin down are not foreign to quantum mechanics.

For a coherent vortex, axial direction and chirality are items of orientation information. They are not merely visual properties. They determine what enters, what exits, how the flow winds, and what type of relationship it can establish with other flows.

[D] Definition of oriented information

A helical flow carries not only numerical information through C_c , C_f , C_e , and α , but also oriented information through its axial direction and chirality. Without these two elements, the geometrodynamic state of the vortex is incomplete.

8.8. Chiral classes — monochirality, bichirality, and fermionic/bosonic behaviors

The previous subsection showed that axial direction and chirality are not simple drawing details of helical flow, but oriented information of the state. A flow is not completely defined only through C_c , C_f , C_e , and α . It must also be defined through the way it winds around its own axis and through the freedom or restriction to exist in one or both possible chiralities.

This specification becomes important because not all classes of helical flows have the same chiral freedom. At a purely geometric level, a helix may be right-handed or left-handed. At the geometrodynamic level, however, a particular class of flow may allow both variants or may be constrained from its genesis to a single variant. Therefore, chirality is not merely the local sign of winding, but a class criterion.

In the simplest formulation, the chirality of a flow may be denoted by two possible values:

$$\chi \in \{+1, -1\}$$

where +1 and -1 designate the two fundamental directions of winding relative to the same selected axial direction. This sign cannot be established independently of the axis. *The functional direction S of transport must first be fixed; only then can the winding be identified as right-handed or left-handed.*

A class of flows is bichiral when the same kinematic identity can naturally appear in both chiralities. In this case, the class is not tied exclusively to a single internal orientation, but accepts the two chiral variants as possible states of the same geometrodynamical family:

$$\mathbf{B}\chi = \{+1, -1\}$$

A class of flows is monochiral when the same kinematic identity can naturally appear in only one chirality. In this case, chirality is not selected accidentally during evolution, but is fixed by the genesis conditions of that class:

$$\mathbf{M}\chi = \{\chi_0\}, \text{ where } \chi_0 \in \{+1, -1\}$$

This distinction changes the way the state is defined. The extended state of a helical flow must include not only the state constants and coupling number, but also the axial direction, effective chirality, and the chiral class to which the flow belongs:

$$\mathcal{S}\chi_{\text{ind}} = (\mathbf{C}_c, \mathbf{C}_r, \boldsymbol{\eta}, \mathbf{S}, \chi, \varphi, \mathbf{X}\chi)$$

In this notation, S represents the axial direction, χ represents the effective chirality, and $\mathbf{X}\chi$ represents the set of chiralities permitted for that class. If $\mathbf{X}\chi$ contains both values, the flow belongs to a bichiral class. If $\mathbf{X}\chi$ contains a single value, the flow belongs to a monochiral class.

From this perspective, the behavior called fermionic in this work must not be introduced directly through particles, but through a chiral restriction. A monochiral flow has less freedom of coupling. It cannot be freely replaced by its mirror image, because that image does not naturally belong to the same class. Therefore, the monochiral regime behaves analogically as fermionic: it is more selective and restrictive and requires more stringent conditions of continuity.

Fermionic regime: $\mathbf{X}\chi = \{\chi_0\}$

By contrast, the behavior called bosonic in this work appears when a class can naturally exist in both chiralities. Such a class has greater freedom of aggregation, lateral induction, and participation in collective structures, as long as α remains compatible. In this sense, the bichiral regime behaves analogically as bosonic:

Bosonic regime: $\mathbf{X}\chi = \{+1, -1\}$

This use of the terms fermionic and bosonic is geometrodynamical and analogical. In current physics, fermions and bosons are defined through spin and the associated quantum statistics. The Unified Theory does not invalidate this definition and does not claim to replace it directly. Instead, it proposes a deeper geometric criterion of interpretation: restrictive or collective behaviors may be read, at the level of helical flows, through the chiral class of the state.

The immediate consequence is that α is not sufficient to determine coupling completely. Two flows may have the same value of the geometrodynamical compatibility parameter, but may fail to couple if their axial direction or chirality is incompatible with the active kernel. Actual compatibility requires an extended state:

$$\alpha_i = \alpha_j \text{ is not sufficient without } (\mathbf{S}_i, \chi_i, \mathbf{X}\chi_i) \text{ compatible with } (\mathbf{S}_j, \chi_j, \mathbf{X}\chi_j)$$

For lateral C-C coupling, the minimal condition remains compatibility through α , but this compatibility must be filtered through the chiral class. In a bichiral regime, collective adjacencies, bundles, and lateral inductions may exist in which both chiralities are permitted. In a monochiral regime, the same attempt at adjacency may produce geometric stress if one of the flows requires a chirality that does not belong to the permitted class.

$$\mathbf{K}_{CC}: |\alpha_i - \alpha_j| \leq \varepsilon \alpha \text{ (hypothesis) and } \chi_i, \chi_j \in \mathbf{X}\chi$$

For M-C axial continuity, the condition is more stringent. Here it is not sufficient for two flows to have the same α . They must preserve the same kinematic identity, the same compatible axial orientation, and the same effective chirality. M-C therefore represents the closest form to analogical fermionic behavior: axial continuity does not allow broad freedom of substitution.

$$\mathbf{K}_{MC}: (\mathbf{C}_c, \mathbf{C}_r, \boldsymbol{\eta}, \mathbf{S}, \chi, \varphi)_i = (\mathbf{C}_c, \mathbf{C}_r, \boldsymbol{\eta}, \mathbf{S}, \chi, \varphi)_j$$

The kernel C-A has a special role because it is linked to the genesis of the flow. At the C-A stage, the potential difference, the attractor, and the initial environmental conditions may select the chiral class of the flow. If the environment permits both windings, a bichiral family may emerge. If the environment imposes a single stable winding, the flow is born monochiral. In this sense, monochirality is not a mere momentary preference, but may be a condition governing the genesis of the class.

$$\mathbf{K}_{CA} \rightarrow \text{initial selection of } \mathbf{X}\chi$$

The T–C kernel introduces another problem: the transition between axial and toroidal transport, a monochiral inductive transfer. In this transformation, chirality does not disappear, but is redistributed relative to the toroidal plane and the induced cylindrical axis. T–C may function as a geometric filter: certain orientations produce continuity, while others produce closure, blockage, or reconfiguration.

K_{TC}: axial transport ↔ toroidal organization, filtered through S and χ

Therefore, kernel interactions must always be read through three levels. The first level is the state relation, given by α . The second level is orientation, given by S and χ . The third level is the chiral class, given by $X\chi$. Only together can these three levels determine whether two flows couple, align, aggregate into a bundle, continue axially, repel one another, or enter decoherence.

candidate coupling $\Rightarrow$ compatibility($C_c, C_r, \eta, S, \chi, \phi, X\chi, K$)

$\chi_i \notin X\chi_i \Rightarrow$ geometric stress or decoherence

This classification explains why a flow may possess memory and information without all of its states being interchangeable. Memory is hypothetically supported by preservation of the independent vector and topological constraints; information is given by the specific values of the components. The chiral class specifies the admissible orientations. The number α may be calculated and compared, but it does not add an independent coordinate and does not determine class membership by itself.

This observation has cautious links to current physics and biology. In chemistry, chiral molecules may have right- and left-handed forms, and living systems selectively use certain chiralities. In particle physics, the distinction between fermions and bosons is established through strict quantum criteria, but the difference between restrictive individual behavior and collective behavior remains an important conceptual reference point. *The Unified Theory uses these facts not as direct demonstrations, but as anchors for the idea that orientation and symmetry class may have major physical consequences.*

For the proposed taxonomy, the chiral class is a distinct criterion. Two flows with the same α may belong to different classes if their independent vectors or chiral classes differ. Conversely, visibly different flows may belong to the same family if their states remain within the same tolerance domain. The classification is therefore a hypothesis based on state information, not on visual similarity.

geometrodynamic class = $f(C_c, C_r, \eta, S, \chi, \phi, X\chi, K)$

In the evolutionary reading of the Unified Theory, this criterion becomes decisive. Monochiral classes are more restrictive and more fragile under changes in orientation, but they can produce coherent axial chains and firmly defined identities. Bichiral classes are more flexible and can participate more readily in bundles, aggregations, and collective processes. Neither class is absolutely superior. Each has its own geometrodynamic advantage: monochirality provides rigor of identity, while bichirality provides freedom of collective organization.

[D] Definition of the chiral class

Chirality is oriented state information. A helical flow may belong to a bichiral class if both chiralities are admitted, or to a monochiral class if the model permits only one. Fermionic or bosonic analogies may be discussed only as geometric analogies, not as deductions of quantum spin and statistics. The α filter is insufficient; the independent vector, the chiral class, the relative geometry, and the dynamics of the kernel must be compared.

8.9. IN–path–OUT as a process of reading, transporting, and rewriting information

The IN–path–OUT architecture was introduced as the functional form of the vortex tube. In the present chapter, it acquires an additional meaning: it is the way in which state information is received, preserved, and transmitted.

IN is not merely an inlet for mass or energy. It is the region in which the flow is prepared for coherence. Here, compatible fluxes are selected, roots are compacted, lines are organized, and the possibility of conservation is established. In informational language, IN is the region where the state is read and prepared.

The path is not merely the transport segment. It is the region in which memory must be preserved to the greatest degree. Here, the independent vector ($C_c, C_r, \eta, S, \chi, \phi$) must remain within the limits of coherence; C_f and C_e can operationally verify the rotational component, while α is recalculated from the Preda quantities. If the path preserves the state, the system transports not only matter, but also geometrodynamic information.

OUT is not mere dissipation. It is the region in which state information is transferred to the attractor, to branches, to bundles, or to compatible regions. At OUT it is determined whether the system continues, branches, induces a new flow, or loses its identity.

This sequence may be written as follows:

$$I_{IN} \rightarrow I_T \rightarrow I_{OUT}$$

In an ideal coherent regime:

$$I_{IN} \approx I_T \approx I_{OUT}$$

This relation expresses the faithful transport of state information. In a perturbed regime, a difference appears:

$$\Delta I = I_{OUT} - I_{IN}$$

If ΔI remains within the coherence tolerance, the system adapts. If ΔI becomes too large, memory breaks down and decoherence occurs.

It must be emphasized that information is not transported separately from the flow. There is no message external to the tube. Information is the state of the tube itself, expressed through the conserved values of its constants and through orientation. The tube transports information because it transports its own state.

This interpretation connects the theory to known systems. In biology, genetic information is ineffective if it cannot be read, replicated, and expressed. In physics, state information is relevant only if it influences the evolution of the system. In the Unified Theory, geometrodynamic information is relevant because it determines axial continuity, lateral coupling, or the survival of the flow.

[H] Proposition of IN–path–OUT information transport

IN prepares state information, the path conserves it, and OUT transfers it to the attractor or to compatible flows acting as secondary attractors. A coherent vortex tube transports information because it transports its own geometrodynamic state.

8.10. Replication of information through the C–C kernel

Among the fundamental kernels, C–C has a special role in the problem of memory and information. It does not describe end-to-end axial extension, but a lateral relationship between flows with parallel or compatible axes. Through this relationship, a mature flow may induce the emergence of an adjacent flow or aggregate into a bundle. Adjacency is always antichiral.

This property introduces a profound idea: geometrodynamic information may be replicated laterally, but in mirrored form. Not in a strictly biological sense, not through molecules and genetic code, but through kinematic induction. A coherent flow may impose on the surrounding environment an organization compatible with its own state.

Under the lateral-replication hypothesis, a first scalar compatibility filter is:

$$\alpha_i = \alpha_j$$

For more faithful replication, the condition becomes stronger:

$$I_{GD}^{(j)} \approx I_{GD}^{(i)}$$

[H] Under the lateral-replication hypothesis, the new flow would receive not only a similar form, but a state close to and mirrored relative to the initial flow. Fidelity must be measured by a metric defined on normalized components of the vector (C_c , C_r , η , S , χ , ϕ); agreement in α follows only if the Preda quantities correspond, while the reversal of chirality remains a testable rule of the model.

The replication kernel may be written as follows:

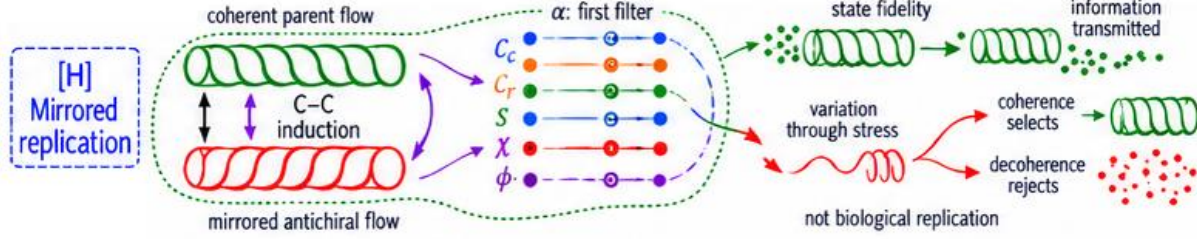
$$K_{CC}(I_i) \rightarrow I_j \approx I_i$$

This relation is one of the most important bridges toward geometrodynamic Darwinism. For selection to be meaningful, memory, information, replication, and variation must exist. The C–C kernel provides the mechanism through which a state may produce a similar mirrored state. Geometric stress provides the mechanism through which differences arise. Coherence or decoherence provides selection.

It must be stated cautiously: C–C is not DNA, it is not cell division, and it is not a direct biological mechanism. But it may be interpreted as a geometrodynamic prototype of replication: an organized state induces a compatible mirrored state nearby.

This idea is powerful because it transforms the vortex from a simple transport structure into a structure capable of transmitting state. Wherever state transmission exists, the possibility of

geometrodynamic genealogy arises: flows that induce flows, bundles that grow, branches that multiply, and systems that preserve or modify their internal information.



[H] Hypothesis of lateral replication — a mirrored state

The C–C kernel permits the lateral transmission of geometrodynamic information. A coherent flow may induce a compatible flow, partially or faithfully preserving the mirrored state values that define its memory.

8.11. Memory distributed among roots, subroots, branches, and subbranches

A mature vortex tube must not be understood as an isolated column. It may be formed from filaments that, through their positioning, become roots, subroots, branches, and subbranches. Each may have its own local organization, but it cannot remain completely independent if the whole is coherent.

The tube's memory is distributed. It resides not only on the principal axis or in the core: it is carried by the constituent lines, by how they are linked, by the local values of the independent vector, and by compatibility among roots or branches. The ratio α may summarize part of the scalar information, but it is not an independent component of memory.

For a branch/root k , the local information may be written as:

$$I(k) = (C_c(k), C_r(k), \eta(k), S(k), \chi(k), \phi(k))$$

For a tube formed from several branches/roots, the total information may be regarded as an ensemble:

$$I_{tube} = \{I_1, I_2, I_3, \dots, I_n\}$$

Global coherence does not require all branches or all roots to be identical, but compatible according to a stated criterion. They may have different roles: some feed, others conduct or redistribute. Fragmentation is predicted only if a state metric and a measurable threshold show that the coherent domain has been exceeded.

A general condition of distributed coherence may be written:

$$D(I_k, I_{tube}) \leq \epsilon_I$$

where D is a dimensionless metric defined on normalized components, and ϵ_I is the informational tolerance of the ensemble. Categorical components, such as direction and chirality, require explicit penalties and are not directly subtracted. Each root or branch must remain sufficiently compatible with the global state of the tube.

This perspective explains why a local perturbation may affect the entire system. If a root or branch changes its state information beyond the threshold, the ensemble must adapt. If adaptation is possible, global memory is preserved through redistribution. If it is not, local or global decoherence occurs.

Distributed memory prepares the chapter on helical kinematic interdependence. There it will be shown how the perturbation of one line is transmitted transversely to the others and how each filament adapts its own axial geometry to maintain shared coherence.

[H] Proposition of distributed memory

The memory of a mature vortex tube is distributed among the filaments along the trunk and, at the IN and OUT ends, among roots/subroots and branches/subbranches. The coherence of the ensemble does not require perfect local identity, but compatibility among the state information of its components.

8.12. Loss of memory: stress, decoherence, and reconfiguration

Geometrodynamic memory is not guaranteed. It must be maintained. The environment may impose deformations, incompatible interactions, flow-rate variations, local ruptures, changes in chirality, reconnections, or excessive branching. All of these may produce geometric stress and informational stress.

Geometric stress was defined as the difference between the geometry imposed by the environment and the geometry required for conservation of the constants. In the terms of the present chapter, it may also be regarded as pressure on memory. The system is forced to change; memory is compelled to defend itself through adaptation.

The informational deviation may be written:

$$\Delta I = D(I_{GD}(t), I_{GD}(0))$$

In the coherent regime:

$$\Delta I \leq \varepsilon_I$$

When the deviation exceeds the threshold:

$$\Delta I > \varepsilon_I$$

the system can no longer preserve its former state information. This is the loss of geometrodynamical memory.

Loss of memory does not mean the absolute disappearance of matter or energy. It means the loss of identity of the former flow regime. What was a coherent tube becomes a disorganized state, a separate branch, a new flow, or a reconfigured ensemble.

The transition may be written:

$$I_{old} \xrightarrow{\Delta I > \varepsilon_I} \text{decoherence} \rightarrow I_{new}$$

This relation is very important. It shows that decoherence is not merely destruction, but also a possibility of reconfiguration. The old memory is lost, but a new memory associated with a new set of constants may emerge.

In this sense, decoherence is the death of a state, not necessarily the end of the process. Flows that can no longer defend their memory break away from the old regime. If the environment permits, they rearrange into a new coherent state. This is one of the direct bridges toward geometrodynamical Darwinism: survival belongs not to rigid forms, but to states capable of conserving their memory or generating a new memory.

[H] Proposition of memory loss

A vortex loses its geometrodynamical memory when the deviation of state information exceeds the tolerance of coherence. Decoherence destroys the old identity, but may open the way for a new state and a new memory to emerge.

8.13. Taxonomy of flows according to state information

If the values of the constants are information, then helical flows may be classified according to the information they carry. This idea introduces the possibility of a geometrodynamical taxonomy.

In biology, species are distinguished through traits, reproduction, descent, and genetic information. In chemistry, elements are classified through atomic properties. In physics, particles are classified through mass, charge, spin, and other quantum numbers. In the Unified Theory, coherent helical flows may hypothetically be classified through domains of the vector $(C_c, C_r, \eta, S, \chi, \varphi)$, dominant kernels, and topological memory; α may be reported as a derived diagnostic.

A geometrodynamical class may be defined through a domain of values:

$$C_m = \{I_{GD} \mid I_{GD} \in D_m\}$$

where D_m is the informational domain of the class. Two flows belong to the same class if their state information is sufficiently compatible.

For a minimal classification, the following criteria may be used:

$$\mathcal{C} = \mathcal{C}(C_c, C_r, \eta, S, \chi, \varphi, \mathcal{K})$$

where K represents the dominant kernel or the type of interaction through which the flow is maintained, extended, or replicated.

This taxonomy must not be understood as a final numerical table. At this stage, it is a principle of organization. *If the theory states that the values of the constants are information, then flows must not be treated as isolated events, but as families of states.* Some may be laterally compatible. Others may be axially compatible. Some may induce replication. Others may produce decoherence.

Here the idea of a possible table of coherent helical flows emerges. Not a periodic table in the strict chemical sense, but a table of state classes. In such a table, flows would be grouped according to their internal information, their capacity for coupling, and their mode of interaction.

This direction is important for the development of the theory. Without taxonomy, each vortex is analyzed separately. With taxonomy, families, classes, compatibilities, state mutations, replications, and geometrodynamic genealogies emerge.

[D] Definition of geometrodynamic taxonomy

If state values are information, coherent helical flows may be classified according to domains of the independent vector (C_c , C_r , η , S , χ , ϕ) and according to the dominant kernels. C_f and C_e remain two pathways of rotational measurement, while α is a derived diagnostic, not an additional coordinate.

8.14. Links with current physics and biology

The idea that systems may possess memory through a conserved state is not foreign to current science. In physics, many systems are characterized through conserved quantities, symmetries, initial states, boundary conditions, and numbers that determine subsequent evolution. In thermodynamics, the state of a system controls its possible transformations. In fluid mechanics, circulation, vorticity, and helicity may describe the persistence of structures. In information theory, information is related to differences of state and the possibility of distinguishing among configurations. [14,15]

The Unified Theory belongs to this general direction, but formulates its own hypothesis: in coherent helical flows, the independent state vector and the topological constraints may constitute the support of geometrodynamic memory. The Preda triplet provides the operational measurement, while α is a derived diagnostic.

The connection with biology must be treated cautiously. It is not claimed that DNA is merely a vortex or that genetic mechanisms can be reduced directly to vortex tubes. A more general statement is made: life uses memory, information, replication, variation, and selection. If these properties already appear at a geometrodynamic level, then biology may be regarded as a complex specialization of a more general mechanism for conserving and transmitting state.

In this reading, DNA is a biological example of materialized memory, while the coherent vortex is a geometrodynamic example of memory through conservation. Helical geometries and the logical structure share a profound similarity: a state is preserved, transmitted, modified, and may be selected.

This connection prepares the next chapter. Geometrodynamic Darwinism is not a simple biological metaphor applied to fluids. It is the attempt to formulate adaptation, selection, and reconfiguration as general processes of coherent systems that carry memory and information.

In current physics, this direction must be tested through concrete models: simulated helical flows, real vortex tubes, optical vortices, quantum vortices, Beltrami structures, plasma filaments, and helical transport systems. In each case, the question is the same: are there state quantities that are conserved during adaptation and whose values determine interaction compatibility?

Clarification of the scientific bridge

Memory and geometrodynamic information do not replace established concepts in physics or biology, but propose a common level of interpretation: coherent states are maintained through conserved quantities, while the values of these quantities determine the evolution and compatibility of the system.

8.15. Conclusion — the vortex as a carrier of state

This chapter has introduced an essential component of the Unified Theory: the coherent vortex is not merely a form, not merely a motion, and not merely an interaction. It is a carrier of state.

This state has memory through preservation of its independent components and information through their specific values. C_c describes flow-rate variation, C_r the rotational level, η the axial–tangential ratio, while S , χ , and ϕ add orientation and phase. C_f and C_e are operational channels of C_r ; α remains a derived diagnostic. Helicity, together with L_k , T_w and W_r , completes topological memory.

The complete information of the tube may therefore be written synthetically:

$$\mathbf{I}_{ext} = (C_c, C_r, \eta, S, \chi, \phi, H, L_k, T_w, W_r)$$

This information is not abstract. It controls adaptation, coupling, branching, replication, decoherence, and reconfiguration. The tube remains the same system as long as it can preserve its information within the limits of coherence. When it can no longer do so, the old state dies geometrodynamically and a new state may emerge.

Through this interpretation, the Unified Theory acquires an evolutionary level. If memory exists, transmission may exist. If transmission exists, variation may exist. If variation exists, selection may exist. If selection exists, evolution may exist.

Thus, the next chapter must treat adaptation as a fundamental principle of the theory. Geometrodynamic Darwinism begins not in biology, but in the capacity of flow systems to preserve, transmit, modify, or lose state information.

[H] Proposition of the vortex as a carrier of state

A coherent vortex has memory through preservation of the constants and information through their values. It is not merely flow, but a state conserved in motion; not merely geometry, but geometrodynamic information transported, adapted, and transmitted.

9. F.T.W. — drift, perturbation, and geometrodynamic propagation

9.1. From state information to perturbation information

The preceding chapter established that a coherent vortex has memory through conservation of the constants and information through the values of those constants. This information does not, however, remain inert. In an open system, memory is continually exposed to the environment, lateral interactions, potential differences, flow-rate variations, and geometric pressures. *Every coherent flow must therefore be capable of receiving, transmitting, and compensating for perturbations without immediately losing its identity.*

At this point, an intermediate concept is needed between state information and the structural response of the system. This concept is the Fundamental Torsion Wave — F.T.W. Within the Unified Theory, F.T.W. does not denote a wave in the usual sense of classical physics. It denotes the drift dynamics produced when a coherent helical flow is locally deflected through lateral interaction.

A coherent helical flow may be described through the independent vector $(C_c, C_r, \eta, S, \chi, \phi)$, while C_f and C_e remain the two operational pathways for determining C_r . The number α is calculated from the Preda quantities and may be tested separately as a hypothetical scalar filter of interaction.

$$\mathcal{S}_i = (C_{ci}, C_{ri}, \eta_i, S_i, \chi_i, \phi_i)$$

Nevertheless, in an open system the state is not only conserved; it is also subjected to stress. The external environment may introduce lateral pressures, other vortices may induce deflections, and neighboring branches or filaments may transmit differences in motion. At that moment, state information becomes perturbation information.

$$\Delta \mathcal{S}_i(t) = \mathcal{D}(\mathcal{S}_i(t + \Delta t), \mathcal{S}_i(t))$$

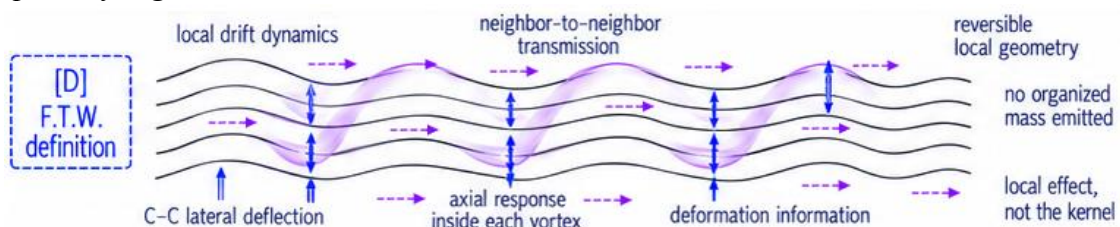
Here D is a dimensionless metric on normalized components, with explicit rules for direction and chirality; vectors with units or categorical variables are not directly subtracted. A small variation does not automatically mean loss of identity. If the system can absorb it and transmit it coherently to neighboring structures, the model calls this the F.T.W. propagation regime.

9.2. Definition of the Fundamental Torsion Wave

In the mature formulation of the Unified Theory, the Fundamental Torsion Wave may be defined as follows:

[D] Definition — F.T.W.

The Fundamental Torsion Wave is the local drift dynamics of a coherent helical flow, produced through a C–C lateral deflection and transmitted axially within each affected vortex, without emission or absorption of organized mass.



This definition removes a possible confusion: F.T.W. is not the unloading or loading of mass. Nor should it be confused with a material whip, meaning the lateral detachment of a branch or peripheral layer. F.T.W. is subtler: it is the propagation of a deviation, a local deformation, a piece of perturbation information.

If a coherent vortex is laterally influenced by another vortex, by a bundle, or by a local state difference, it does not respond only through displacement of its entire mass. It first responds through a local change in its geometry. This change may be small, reversible, periodic, or intermittent. When it is transmitted from neighbor to neighbor, the behavior called F.T.W. emerges.

$$\text{FTW}_{i \rightarrow j} = K_{CC} (\Delta \mathcal{S}_i \rightarrow \Delta \mathcal{S}_j)$$

The formula must not be read as a final calculation equation, but as a relation of principle: a perturbation of state i is transmitted to state j through the lateral C–C kernel. F.T.W. is the local effect of this transmission, not the kernel itself.

9.3. Why F.T.W. is linked to C–C interaction

The C–C kernel was defined as a lateral interaction between cylindrical helical flows. It is the kernel of adjacency, lateral induction, replication, and bundle formation. For this reason, it is the natural support of F.T.W. An F.T.W. perturbation does not arise through axial end-to-end contact, as in M–C, nor through perpendicular torus–cylinder induction, as in T–C. It arises when two neighboring helical flows influence each other laterally.

In geometric language, C–C means that the flow axes remain distinct, but sufficiently close to transmit deviations to one another. If one of the flows receives a deformation, the neighboring flow need not immediately absorb mass and need not reconnect. It may first receive a change in orientation, phase, lateral pressure, curvature, or local torsion.

This lateral transmission is the mature image of drift. Drift is not a simple mechanical sliding, but a local displacement of the geometrodynamical path under the influence of a neighboring state. It is the result of the fact that vortices do not exist as isolated objects, but as open systems, compatible or incompatible through α , axial direction, chirality, and internal state.

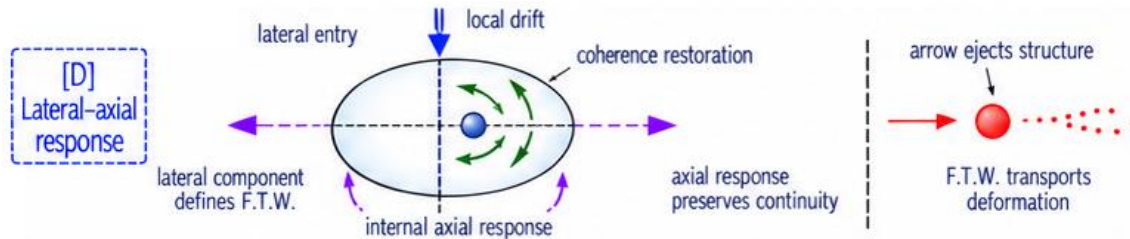
$$\Delta \alpha_{ij} = |\alpha_i - \alpha_j|$$

$$\Delta \alpha_{ij} \leq \varepsilon_\alpha \rightarrow \text{coherent propagation}$$

$$\Delta \alpha_{ij} > \varepsilon_\alpha \rightarrow \text{stress, filtering, or local decoherence}$$

9.4. Lateral propagation and axial response

F.T.W. has an important particularity: its induction mechanism is lateral, but the response of each affected vortex is also transmitted axially along that vortex's own direction. This dual nature can create confusion if it is not specified from the outset.



The perturbation enters laterally because it comes from a neighboring vortex, a neighboring branch, or an adjacent flow. It therefore belongs to the C–C regime. *After entering the local structure, each affected filament must restore its own internal coherence. This restoration occurs not only at the point of contact, but along its own axial direction.*

$$\delta \mathbf{r} = \delta \mathbf{r}_{\text{perp}} + \delta \mathbf{r}_{\text{ax}}$$

$$\delta \mathbf{r}_{\text{perp}} \perp \mathbf{a}$$

$$\delta \mathbf{r}_{\text{ax}} \parallel \mathbf{a}$$

In these relations, $\mathbf{a}$ represents the local axial direction of the vortex, $\delta \mathbf{r}_{\perp}$ is the lateral component of drift, while $\delta \mathbf{r}_{\parallel}$ is the internal axial response. The identity of F.T.W. is given by $\delta \mathbf{r}_{\perp}$, because the perturbation is introduced laterally; axial propagation is the way in which each vortex adjusts its own continuity.

F.T.W. may therefore be described by the conceptual formula:

$$\mathbf{F.T.W.} = \text{lateral C-C drift} + \text{internal axial response}$$

This is the essential distinction. Axial propagation, or a longitudinal wave, is not an arrow. The arrow implies the axial ejection of an organized structure of mass or momentum. F.T.W. includes the transmission of the axial component of a perturbation within the affected vortex. The arrow transports structure; the wave transports local deformation, both transversely and longitudinally.

9.5. Inductive, attractive, and repulsive deviations

In the initial formulation of the theory, F.T.W. transmission was linked to local deviations of helical dynamics produced by systems of influence. This idea will be retained, but it must be clarified in the current language of kernels.

An F.T.W. deviation may have three fundamental characters: inductive, attractive, or repulsive. These are not separate forces in the classical sense, but modes of modifying the local path of the flow.

Type of deviation	Geometrodynamic meaning
Inductive	the neighboring flow imprints a change of orientation, phase or torsion without direct capture; it is the purest form of C-C drift.
Attractive	the flow is deflected toward a compatible region, toward a neighboring axis or toward a potential region that favors approach (absorption).
Repulsive	the flow is deflected through avoidance, separation or geometric repulsion from an incompatible state (reflection).

$$\mathbf{D_{FTW}} \in \{\mathbf{D_{ind}}, \mathbf{D_{atr}}, \mathbf{D_{rep}}\}$$

This classification is important because it permits a richer description of lateral interaction. Not every lateral deviation leads to approach. Some produce synchronization, others produce separation, and still others produce a simple change in phase or plane of oscillation. F.T.W. is the common regime through which these differences become transmissible.

9.6. Amplitude, frequency, phase, and polarization

A single perturbation may produce only a local deviation. For it to be recognized operationally as a wave, repetition, rhythm, or a coherent succession of deviations must exist. Therefore, within F.T.W., the concepts of amplitude and frequency are introduced not as properties of an abstract field, but as properties of repetitive drift.

$$\begin{aligned} \mathbf{A_{FTW}} &= \max |\delta \mathbf{r_{perp}}| \\ \mathbf{f_{FTW}} &= 1 / \mathbf{T_{FTW}} \end{aligned}$$

The amplitude $\mathbf{A_{FTW}}$ expresses the maximum magnitude of lateral displacement. The frequency $\mathbf{f_{FTW}}$ expresses the repetition rate of the deviation. If the perturbing system acts periodically or nearly periodically, drift acquires a wave-like character. If the action is irregular, F.T.W. appears as a train of perturbations, pulses, or intermittent deviations.

Phase describes the relative position of the drift cycle with respect to a reference. Two neighboring flows may be compatible through α , but shifted in the phase of their drift. In that case, the interaction may produce delay, filtering, amplification, or local cancellation of the perturbation.

$$\Delta \phi_{ij} = \phi_i - \phi_j$$

F.T.W. polarization is the dominant orientation of the plane in which lateral drift occurs. It must not yet be confused with the polarization of light, which will later be reinterpreted in relation to the helical jet. Nevertheless, the analogy is useful: if drift has a preferred plane, the system may transmit, block, or select the perturbation according to the orientation of that plane.

$$\mathbf{P_{FTW}} = \text{plane}(\mathbf{a}, \delta \mathbf{r_{perp}})$$

9.7. F.T.W. as deformation information

Chapter 8 established that the values of the constants represent state information. F.T.W. introduces a second level: deformation information. This indicates not only what the flow is, but how it is locally deflected and how it responds to the deviation.

Deformation information may be described through local variations of the extended state:

$$\mathbf{I_{def}} = (\Delta \mathbf{C_c}, \Delta \mathbf{C_r}, \Delta \mathbf{\eta}, \Delta \mathbf{S}, \Delta \mathbf{\chi}, \delta \mathbf{r_{perp}}, \delta \mathbf{r_{ax}}, \Delta \mathbf{\phi})$$

Not all of these variations occur simultaneously. Sometimes drift changes only the local position of the axis. At other times it changes phase, torsion, cross-section, or compatibility through α . What matters is that the perturbation has informational content. It informs the neighboring flow that the environment has changed, that another vortex is nearby, or that a local state must be compensated.

In this sense, F.T.W. is the first mechanism through which geometrodynamic memory becomes sensitive to the exterior. A system that did not transmit perturbations could not adapt coherently. A system that transmitted only mass, through emission or absorption, would react too violently. F.T.W. provides the intermediate stage: change without rupture, deviation without decoupling, communication without absorption or ejection.

9.8. The difference between F.T.W., IN–OUT, and structural emission/absorption

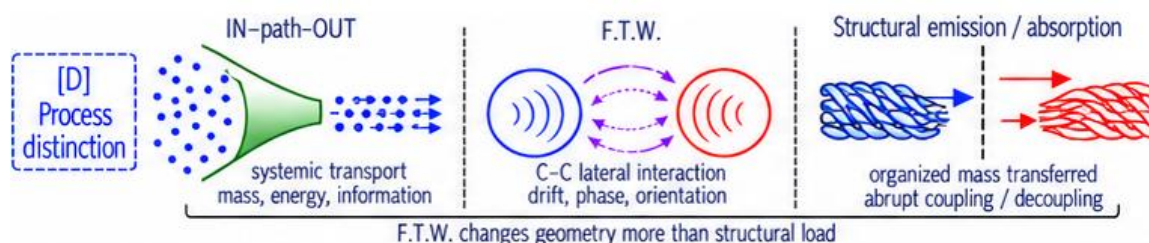
A very clear distinction is required among three processes that may appear similar: F.T.W., IN–OUT, and structural emission/absorption.

IN–OUT describes the functional architecture of a vortex tube: capture, path, and conduction toward the attractor. This scheme belongs to systemic transport. It describes how the flow enters, becomes organized, and exits within a coherent system.

Structural emission and absorption describe a more abrupt regime: the system may receive or release entire vortices, roots, branches, layers, or fragments of helical jet. Organized geometrodynamic mass is transferred there. This process will be addressed in the next chapter.

F.T.W. lies between these two registers. It is not the general IN–OUT architecture and it is not structural mass transfer. It is the propagation of a deviation.

Process	What it transmits	Dominant regime
IN–path–OUT	mass, energy and information through the functional path of the tube	systemic transport
F.T.W.	deformation, drift, phase, orientation and perturbation information	C–C lateral interaction
Structural emission/absorption	mass, entire vortices, branches, jet layers, or individual helical jets	abrupt coupling/decoupling



$$|\Delta M_{gd}|_{FTW} \ll |\Delta M_{gd}|_{emission}$$

This inequality expresses only a scale hypothesis: in F.T.W., variation in the inventory of geometrodynamic mass would be secondary to geometric change, while emission or absorption changes the structural load. Seasonal adaptation in organisms may serve only as a distant analogy for reversible change without loss of identity; it is not an F.T.W. mechanism and does not constitute physical evidence.

9.9. F.T.W. and stability through fine adaptation

A coherent system cannot react to every perturbation through rupture, emission, or total reconfiguration. If it did, it would have no stability. True stability requires a fine-adjustment zone in which small or moderate perturbations can be distributed without loss of identity.

F.T.W. is this fine-adjustment mechanism. It permits a vortex to transmit to its neighbors the fact that its local geometry has changed. Instead of rupturing, the ensemble may slightly adjust the drift plane, phase, torsion, or axial direction. If adaptation succeeds, the global state is preserved.

$$\mathcal{D}(\mathcal{S}_1, \mathcal{S}_2) \leq \epsilon_s \rightarrow \text{adaptation through F.T.W.}$$

$$\mathcal{D}(\mathcal{S}_1, \mathcal{S}_2) > \epsilon_s \rightarrow \text{structural stress, emission, or decoherence}$$

This idea prepares geometrodynamic Darwinism. Before a structure is selected, it is tested. The test does not always begin through destruction, but through perturbation. F.T.W. is the form through which the system senses the test, distributes it, and attempts to compensate for it.

9.10. Methodological links with current physics

In current physics, the notion of a wave is used to describe the propagation of a perturbation: mechanical waves in elastic media, waves on the surface of water, sound waves, electromagnetic waves, spin waves, waves in plasmas, or oscillations of vortex lines. These descriptions are operational and have indisputable predictive power.

The Unified Theory does not negate their usefulness. *It does, however, propose a change in the level of interpretation. Instead of regarding the wave as ultimate reality, it treats wave-like behavior as a projection or effect of deeper geometrodynamics. In the case of F.T.W., what propagates is not a wave-like substance, but local deviations of helical flows.*

There are useful analogies with fluid mechanics. A vortex line may support local undulations; a bundle of filaments may transmit phase perturbations; a shear layer may generate rotating structures that influence one another. These analogies do not automatically demonstrate the Unified Theory, but they show that the idea of a perturbation propagated through vortex structures is not foreign to current physics.

There are also analogies with electromagnetism. What physics describes as an electromagnetic wave may, within the theory, be reinterpreted as a measurable effect of deeper helical structures. Although this is an aim of the theory, this chapter does not define light. Light will be addressed separately as a helical jet. F.T.W. remains here the mechanism of drift, deviation, and propagation of perturbation information.

This caution is important. A new theory becomes more solid when it clearly separates levels: the wave model remains a calculation tool; F.T.W. is proposed as a substrate-level geometrodynamics mechanism; light, in its dedicated chapter, will be discussed as a regime of emitted and absorbed helical jet.

9.11. Polarization as selection of drift

Polarization is one of the best conceptual bridges between F.T.W. and observable wave phenomena. In standard physics, polarization describes the orientation of the oscillation of a transverse wave. In the Unified Theory, at the F.T.W. level, polarization may be interpreted as selection of the lateral drift plane.

A system may permit the transmission of drift in a certain plane and block or reduce transmission in another. This selectivity is not a simple mathematical effect, but a geometric compatibility between the perturbation and the receiving structure.

$$T_{FTW} = T(C_c, C_r, \eta, S, \chi, \phi, P_{FTW})$$

Under the model's hypothesis, transmission T_{FTW} depends on the proximity of the independent vectors, the relative geometry, and the dominant drift plane. The value α may be used only as a preliminary scalar filter. This formulation prepares the reinterpretation of light polarization, but does not exhaust it.

9.12. F.T.W. between the local and the tree-like

F.T.W. is, first and foremost, a local mechanism. It occurs between neighboring flows, adjacent filaments, or compatible regions through C–C. Nevertheless, in a mature tube, these local interactions may become part of a much larger architecture.

If a tube develops roots/subroots and branches/subbranches, then a local perturbation may be received by a segment of the tree and then redistributed through the compatibility of roots and branches. This is not yet kinematic correlation in the sense of the dedicated chapter. It is its local basis. Tree-like kinematic correlation will appear in mature form only when these local propagations occur across a coherent tree-like architecture, with a common trunk and roots and branches compatible with a distributed memory.

Therefore, the logical order is important. F.T.W. explains the local transmission of the perturbation. The tree-like architecture will explain the support over which the perturbation is distributed. Tree-like kinematic correlation will explain the global reaction of the tree.

local F.T.W. → coherent tree → kinematic correlation

9.13. Conclusion — *F.T.W. as a mechanism of geometrodynamic communication*

The Fundamental Torsion Wave is one of the concepts required for the Unified Theory to become not merely a theory of states, but a theory of communication among states. The independent quantities describe identity; α is tested as a hypothetical scalar filter; the kernels classify the types of interaction; F.T.W. schematically describes the local mode through which a perturbation is transmitted without the necessary emission of organized mass.

Through F.T.W., a helical flow is not only a carrier of memory, but also a receiver and transmitter of changes. It can sense the environment, deviate, transmit the deviation to its neighbors, produce an internal axial response, and participate in collective adjustments. *F.T.W. is therefore the first form of geometrodynamic communication at a distance among vortices.*

The distinction from emission and absorption is decisive. F.T.W. is not an arrow, not a material whip, and not a light jet. It is torsional drift, meaning the local transmission of deformation information. The next chapter will address the harsher regime of abrupt adaptation, in which the system no longer transmits only perturbation, but absorbs or emits entire vortices, roots, branches, layers, and helical jets.

[H] *Hypothesis of the Fundamental Torsion Wave*

F.T.W. is the geometrodynamic propagation of a local deviation through C–C lateral interaction. It transmits deformation information from vortex tube to vortex tube and produces an axial response in each affected vortex tube, without being confused with the emission or absorption of organized geometrodynamic mass.

When the perturbation can be compensated through drift, the system remains within the F.T.W. domain. When the perturbation exceeds the capacity for fine adjustment, the flow can no longer respond through deviation alone. It may enter an excited regime, absorb compatible vortices, or emit complete vortex structures. This regime represents abrupt geometric adaptation and is the subject of the next chapter.

perturbation → F.T.W. drift → fine adaptation
critical stress → emission / absorption → structural reconfiguration

10. Abrupt adaptation of geometry — *emission/absorption and decoupling/coupling*

10.1. From continuous adaptation to abrupt adaptation through a jump

The preceding chapters established that a coherent vortex tube conserves its identity not through rigidity, but through continuous adaptation of its geometry. The radius, helical pitch, velocities, roots, branches, and internal distribution may change as long as the state of the flow remains compatible with the fundamental Preda constants and with the state relation α .

This continuous adaptation nevertheless has a limit. There are situations in which the system can no longer compensate slowly for the demands of the environment. The perturbation is no longer merely a local F.T.W.-type deviation, and geometric correction can no longer be made through small changes in pitch, radius, or curvature. At that moment, the system passes from the continuous-adjustment regime into the regime of abrupt adaptation through a jump.

Abrupt adaptation is the response through which a helical system rapidly changes its structural load. It may absorb entire vortex lines, decouple roots or branches, emit fragments of helical jet, or detach entire outer layers. Therefore, this is no longer merely deformation, but an exchange of structure.

This distinction is essential. If F.T.W. transmits perturbation, abrupt adaptation transfers structure. The former modifies geometry through drift and internal axial response, while the latter modifies the effective load of the system through absorption, emission, coupling, or decoupling of vortex lines or fragments.

10.2. The extended state and the condition of coherence

To describe abrupt adaptation, one must begin from the extended state of the helical flow. In the form already introduced in the preceding chapters, a coherent flow is defined not only through its visible form, but through constants, the state equation, axial direction, and chirality.

$$\mathcal{S}_{\chi, \text{ind}} = (\mathcal{C}_c, \mathcal{C}_r, \eta, \mathcal{S}, \chi, \varphi)$$

In this notation, $\mathcal{C}_c$ and $\mathcal{C}_r$ describe the independent scalar core, η describes the axial–tangential ratio, $\mathcal{S}$ the axial direction, χ the chirality, and φ the phase. $\mathcal{C}_f$ and $\mathcal{C}_e$ are reported separately as an operational verification, while α is calculated and tested as an auxiliary quantity; it is not conserved as an independent variable.

In the continuous-adaptation regime, variations are compensated locally. The system can withstand changes in geometry without losing its extended state. In the abrupt-adaptation regime, the difference between the state required by the environment and the system's own state exceeds the tolerance of coherence.

$$\begin{aligned} \Delta \mathcal{S}_{\chi} &= \mathcal{S}_{\chi}(t_2) - \mathcal{S}_{\chi}(t_1) \\ |\Delta \mathcal{S}_{\chi}| &\leq \varepsilon_S \rightarrow \text{continuous adaptation} \\ |\Delta \mathcal{S}_{\chi}| &> \varepsilon_S \rightarrow \text{abrupt adaptation} \end{aligned}$$

Here, ε_S must not be understood as an already measured universal constant, but as the internal tolerance threshold of the system. Each class of flows may have a different capacity to withstand state deviation. What matters is the principle: when the deviation exceeds the capacity for slow adaptation, the system is compelled to change structure, not merely form.

10.3. The limit of the IN–path–OUT architecture

The IN–path–OUT architecture describes the normal mode of operation of an open flow: the system receives, organizes, and conducts. IN prepares the flow from compatible regions, the path conserves and stabilizes it, and OUT transmits it to the attractor or to compatible regions. This scheme remains fundamental, but it does not exhaust all real forms of loading and unloading.

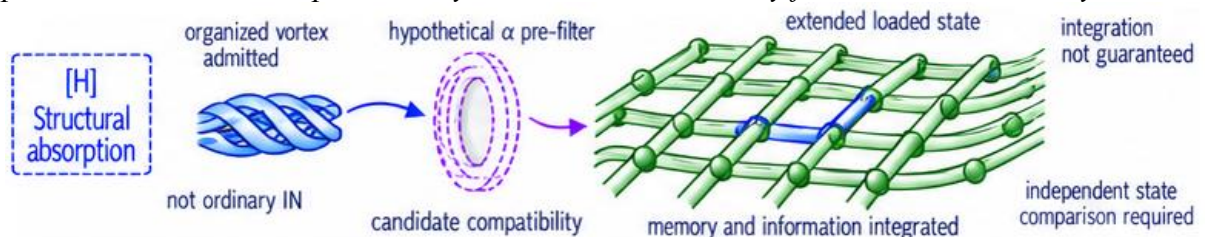
In the classical IN–OUT regime, the system exchanges mass, energy, momentum, or information through the functional and branched ends of the tube. Mass is captured, organized, and conducted. *In abrupt adaptation, the system may exchange already organized structures: entire vortices, roots, subroots, branches, subbranches, peripheral layers, or coherent fragments of helical jet.*

This is a second form of loading and unloading. It does not necessarily occur through the classical ends of the tube, but through structural coupling or decoupling. *The system no longer receives only matter in a diffuse sense; it receives an architecture. It no longer releases only flux; it releases a configuration.*

Therefore, in the Unified Theory two levels must be distinguished: functional transport through IN–path–OUT and structural exchange through coupling/decoupling of constituent vortex tubes. *The first describes the normal circulation of the system. The second describes the adaptive jump of the geometry.*

10.4. Structural loading through vortex absorption

Absorption of vortex tubes is the process through which a coherent flow admits into its own architecture an already organized vortex, root, branch, or helical fragment. It is not identical to ordinary IN. At IN, the system may receive an unorganized or partially organized flux, which it prepares for transport. In structural absorption, the system receives an already formed kinematic entity.



For absorption to be possible, the new structure must be compatible with the extended state of the system. Compatibility does not require perfect identity, but it does require that the state difference can

be integrated without immediate decoherence. In the language of the state relation, absorption is favored when the scalar α of the admitted vortex can be brought into the same coupling family as the absorbing system.

$$\alpha = \frac{C_e \cdot C_f}{C_c^2}$$

$$|\alpha_i - \alpha_s| \leq \varepsilon_\alpha \rightarrow \text{possible absorption}$$

In this formulation, α_i and α_s are the derived state numbers of the entering structure and the absorbing system. The threshold ε_α represents only a hypothetical filter: passing it does not guarantee integration, while exceeding it does not permit rejection or decoherence to be deduced without a dynamic law and without comparing the independent vectors.

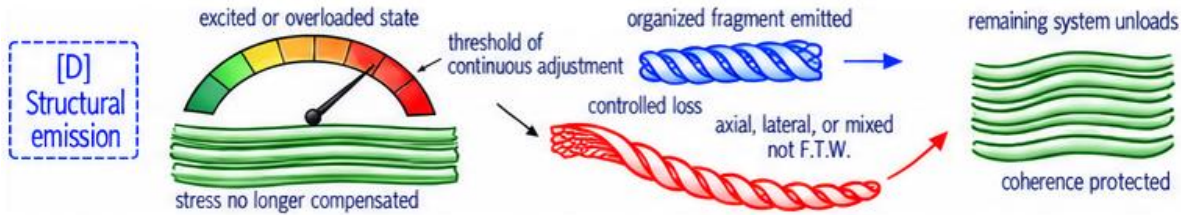
$$\mathcal{S}_0 + V_i \rightarrow \mathcal{S}_1$$

In this notation, $\mathcal{S}_0$ is the initial system, V_i is the admitted vortex or branch, and $\mathcal{S}_1$ is the structurally loaded system. The plus sign does not indicate a simple increase in mass, but the emergence of an extended state in which the geometry of the system must integrate the memory and information of the absorbed structure.

10.5. Structural unloading through vortex emission

The emission of vortex tubes is the reverse process. A system in an excited or overloaded state unloads part of its own architecture as a coherent fragment. This unloading may be axial, lateral, or mixed, depending on the type of decoupling activated.

A flow does not emit merely because it has surplus mass. It emits when the surplus, geometric stress, or state incompatibility can no longer be compensated through continuous adjustments. Emission is a solution of conservation through controlled loss. The system relinquishes part of its structure to avoid total loss of coherence.



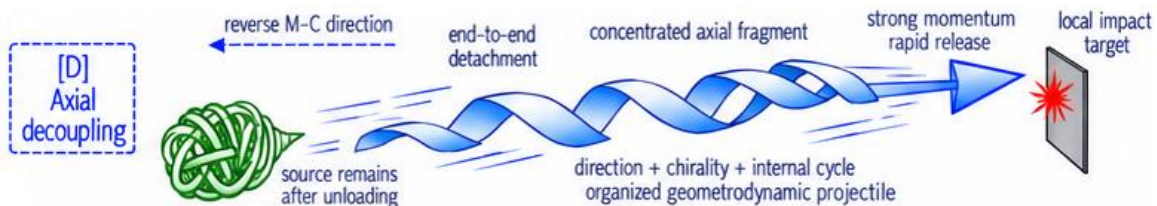
$$S_{ex} \rightarrow S_r + V_e$$

Here, S_{ex} denotes the system in an excited state, S_r denotes the system after unloading, and V_e denotes the emitted vortex structure. Emission may be understood as an abrupt decrease in the internal geometrodynamical load, but not as simple evacuation. What departs is an organized form.

Depending on the orientation of jet decoupling, emission may produce two fundamental images: the helical arrow and the helical whip. Both are forms of structural unloading. Neither should be confused with F.T.W., because F.T.W. is a perturbation wave, not a fragment of organized mass.

10.6. The helical arrow — axial decoupling

The helical arrow is the axial emission of a helical-jet fragment. It occurs when decoupling takes place along the dominant direction of the axis. In this situation, the system rapidly releases a concentrated, oriented structure with strong momentum and a high capacity for impact.



The image of an arrow is useful because it expresses the extreme directionality of the process. The emitted fragment does not detach laterally and does not open like a branch, but leaves the system along its own axis or along a compatible axial direction. It has direction, chirality, an internal cycle, and a

coupling state. *It is a portion of coherent flow transformed into a geometrodynamic projectile conceptually resembling an arrow.*

$$K_{MC,dec}(S_{ex}) \rightarrow S_r + J_a$$

The minus sign associated with the M–C kernel does not introduce a new kernel, but indicates the reverse direction of axial coupling: not end-to-end attachment, but end-to-end detachment. J_a denotes the emitted axial jet. In the coupling regime, M–C extends the structure. In the decoupling regime, M–C releases an arrow.

The arrow is the most powerful form of unloading at impact because it concentrates the transfer of mass, momentum, and state along the axial direction. It is associated with abrupt events, rapid release, and accelerated change in the geometry of the source system.

10.7. The helical whip — lateral decoupling

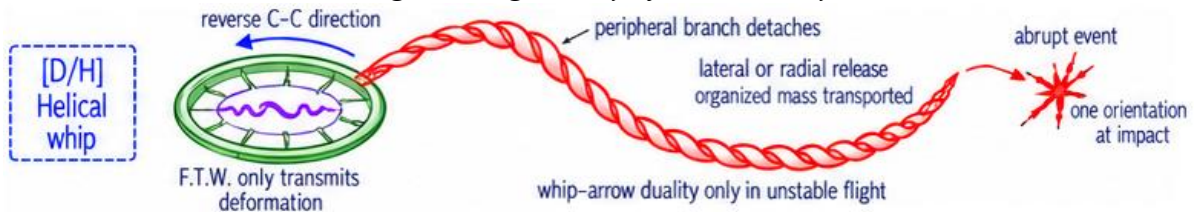
The helical whip is the lateral or radial emission of a root or branch, a peripheral layer, or a bundle fragment. It occurs when the system is organized in layers and part of the periphery suddenly detaches from the ensemble. Bundles of lateral roots or branches, specific to IN or OUT, may also lose structures.

In this case, unloading does not occur through the principal axis, but through the lateral boundary, along the periphery parallel to the axis. The system does not launch an arrow along the direction of central transport, but releases a portion of a constituent vortex tube that bends, strikes, detaches, or reorients laterally. The image of a whip is therefore more appropriate than that of a lateral jet.

$$K_{CC,dec}(S_{ex}) \rightarrow S_r + R_r$$

The minus sign associated with the C–C kernel indicates lateral decoupling. In the positive regime, C–C produces lateral induction, replication, adjacency, and bundling. In the unloading regime, the same logic may produce the detachment of a branch or layer. R_r denotes the released radial branch.

The helical whip visually resembles a lateral wave, but it is not F.T.W. The difference is decisive: F.T.W. is the drift of a perturbation, while the helical whip is the release of a structure. F.T.W. transmits deformation; the whip transports organized geometrodynamical mass. It is associated with abrupt events, rapid release, and accelerated change in the geometry of the source system.



[H] Observation of the duality of the helical jet

At impact, the helical flow has a single orientation, the strike behaving either as a whip or as an arrow. The unstable flight of the jet might be characterized by a whip–arrow duality, with only one of the two forms present at impact.

10.8. Excited states and states favorable to absorption

Emission and absorption are not random events. They occur in particular states of the system. A system may reach an excited state when geometric energy, coupling stress, or surplus structure becomes too great for continuous adaptation. In this state, emission becomes probable because unloading reduces internal stress.

An excited state must not be confused with simple agitation. It is a state in which the system has a structural load incompatible with the stable preservation of the state relation. To return to coherence, the system may emit axially, decouple laterally, or partially fragment a root or branch.

$$G_s > G_{crit} \rightarrow \text{structural emission}$$

Conversely, a state favorable to absorption is one in which the system has a structural deficit, an opening for coupling, or a potential region capable of receiving a compatible vortex. Absorption is not possible merely because a neighboring vortex exists; a compatibility window in the absorbing system is also required.

$$D_s > D_{crit} \text{ and } |\alpha_i - \alpha_s| \leq \varepsilon_\alpha \rightarrow \text{structural absorption}$$

D_s denotes the structural deficit or opening of the system. The formula is not a final numerical law, but a state scheme: absorption simultaneously requires an internal need and external compatibility.

10.9. Kernels as mechanisms of coupling and decoupling

The kernels introduced in Chapter 7 must not be regarded only as modes of coupling. Each kernel may also have a decoupling regime when the system passes from absorption, aggregation, or continuity to emission, detachment, or fragmentation.

C–A describes the relationship between the flow and the attractor. In the coupling regime, the attractor captures, initiates, or organizes. In the decoupling regime, the flow may leave the capture region or be expelled from a region that has become incompatible.

M–C describes axial continuity. In the coupling regime, it extends the chain. In the decoupling regime, it breaks axial continuity and may produce the helical arrow.

C–C describes lateral induction, replication, and the bundle. In the coupling regime, it aggregates, aligns, and multiplies. In the decoupling regime, it laterally detaches roots, branches, layers, or peripheral fragments, producing the helical whip.

T–C describes perpendicular conversion between torus and cylinder. In the coupling regime, it may close, stabilize, or locally transform circulation. In the decoupling regime, it may release an axial structure from a toroidal regime or break a cyclic closure into an open flow.

$K_{coupling} \rightarrow \text{coupling} / \text{absorption} / \text{stabilization}$

$K_{decoupling} \rightarrow \text{decoupling} / \text{emission} / \text{reconfiguration}$

Through this dual orientation, the kernels become complete adaptive mechanisms. They describe not only how bonds form, but also how they break coherently when rupture becomes the only way to conserve the remaining system.

10.10. Attractive, repulsive, and inductive mechanisms

In the regime of abrupt adaptation, the classification introduced for F.T.W. deviations reappears: attractive, repulsive, or inductive effect. The terms do not denote distinct classical forces, but modes of modifying the geometric relationship among helical states.

The attractive mechanism favors capture, approach, absorption, and stabilization within a common architecture. It occurs when a state difference can be transformed into coherent coupling. Where the system has a deficit or opening for coupling, attraction may produce the admission of entire vortices.

The repulsive mechanism favors separation, expulsion, decoupling, and emission. It occurs when two states cannot occupy the same region of coherence or when the system is overloaded. Repulsion does not mean chaos; it may become a mechanism for protecting the remaining identity.

The inductive mechanism favors the transmission of motion, replication, orientation, and the formation of a new structure through lateral or perpendicular influence. It is close to F.T.W. when it transmits only perturbation, but becomes structural when it induces the emergence or detachment of a complete vortex.

Axial induction may occur locally at the coupling or decoupling of flow axes, through the interposition of a third structure, through absorption or emission (mixed). Here the possibility of ejection and local arrow-type emission becomes apparent.

attractive $\rightarrow$ absorption

repulsive $\rightarrow$ emission

inductive $\rightarrow$ lateral = replication / transformation $\rightarrow$ axial = mixed

These three mechanisms explain why abrupt adaptation may take different forms without requiring new kernels. The kernel provides the geometry of the relationship, while the attractive, repulsive, or inductive character describes the effective direction of the transformation.

10.11. The difference between F.T.W. and abrupt adaptation

The preceding chapter defined F.T.W. as the Fundamental Torsion Wave, meaning simultaneous lateral C–C drift and axial transmission of the perturbation within each affected filament. This chapter definitively establishes the boundary between F.T.W. and structural emission or absorption.

F.T.W. transmits perturbation, deviation, and deformation information; its main effect is lateral drift with an internal axial response.

The helical arrow transmits an axial fragment of helical jet; its principal effect is concentrated impact and rapid unloading.

The helical whip transmits a root, a branch, a layer, or a lateral fragment; its principal effect is radial detachment and lateral impact.

Absorption integrates an entire vortex or a coherent structure; its principal effect is the structural loading of the system.

The table showed that F.T.W. belongs to the domain of perturbation, while emission, in the form of an arrow or a whip, as well as absorption, belongs to the domain of structural exchange. This distinction is one of the important clarifications of the Unified Theory. Without it, the wave, absorption, and jet decoupling would be mixed into a single phenomenon, and the theory would lose its power of discrimination.

The distinction must be stated simply: F.T.W. changes geometry through a torsional signal; emission and absorption change geometry through the transfer of structure.

10.12. Methodological links with current physics

Current physics recognizes numerous processes in which a system does not adapt slowly, but abruptly changes regime: vortex shedding in flows, reconnection of field lines in plasmas, astrophysical jets, coronal ejections, fragmentation of fluid jets, cavitation, electrical discharges, and phase transitions. These examples must not be invoked as direct demonstrations of the Unified Theory, but they show that nature frequently uses rapid, discontinuous, or nearly discontinuous responses when slow adaptation is no longer sufficient.

In fluid mechanics, an obstacle may produce periodic vortex shedding. In magnetohydrodynamics, reconnection may rapidly release energy and change the topology of field lines. In astrophysics, accretion disks and active central regions may produce collimated jets over great distances. *In all these cases, the established description remains valid in its own domain, but the Unified Theory proposes a common language: structural adaptation through coupling, decoupling, absorption, and emission.*

This methodological connection is important because the theory does not isolate itself from existing physics. It shows that the new concepts do not arbitrarily replace established terms, but provide an architecture of interpretation that is more general. The abrupt addition or loss of layers, disconnection or reconnection, ejection or rapid absorption of mass, branching, and fragmentation may be read as particular regimes of a broader problem: what does a coherent system do when its own geometry can no longer preserve the state through continuous adaptation?

10.13. Abrupt adaptation and system memory

Emission and absorption change the memory of the system. If an entire vortex is absorbed, the system receives not only mass, but also state information. If a branch is emitted, the system loses not only mass, but also a portion of geometrodynamical memory—part of the values and correlations that participated in its internal identity.

Therefore, abrupt adaptation is not an event external to memory. It rewrites memory. After absorption, the system may have a different internal distribution, a different coherence threshold, and a different capacity for coupling. After emission, the system may become more stable, structurally poorer, more axialized, or, conversely, more vulnerable.

$$\begin{aligned} & \mathbf{M}(\mathbf{S}_0) \rightarrow \mathbf{M}(\mathbf{S}_1) \text{ through absorption} \\ & \mathbf{M}(\mathbf{S}_{ex}) \rightarrow \mathbf{M}(\mathbf{S}_r) + \mathbf{M}(\mathbf{V}_e) \text{ through emission} \end{aligned}$$

In these formulas, M does not denote classical mass, but the state memory of the system. *Absorption adds or reorganizes memory. Emission divides it. In both cases, the system remains identical only if the new state can preserve coherence compatible with its internal equation.*

10.14. Conclusion — adaptation through structural exchange

Abrupt adaptation complements continuous adaptation. A coherent helical system first attempts to modify its geometry through local adjustments: it changes the radius, pitch, velocities, distribution of roots and branches, or internal ratios. If these adjustments are sufficient, the system remains in the same regime. If they are not, it must structurally change its own load.

This structural change may occur through absorption or emission. Absorption admits entire vortex lines or coherent fragments when compatibility permits. Emission releases axial arrows or lateral whips when internal stress requires unloading. Coupling and decoupling are not marginal accidents, but mechanisms through which the system attempts to preserve its coherence.

Through this chapter, the Unified Theory clearly separates three levels: F.T.W. as transmission of perturbation, IN–path–OUT as functional transport, and vortex emission/absorption as structural exchange. This distinction prepares the next chapter, in which light will be reinterpreted not as a fundamental wave, but as a coherent helical jet emitted, transported, and absorbed in axial or lateral regimes.

[H] Hypothesis of adaptation through a jump by structural exchange

When continuous adaptation can no longer conserve the extended state of a helical flow, the system may respond through absorption or emission of complete vortex structures. F.T.W. transmits perturbation; abrupt adaptation transfers structure. The helical arrow is axial unloading, the helical whip is lateral unloading, and absorption is structural admission compatible with the state relation of the system.

11. Light as a helical jet — geometrodynamic hypothesis and correspondence requirements

11.1. From wave to jet

The preceding chapters separated two mechanisms that must not be confused. The Fundamental Torsion Wave describes local drift, namely the transmission of a perturbation through lateral deflection and an internal axial response. Abrupt adaptation, by contrast, describes the emission or absorption of organized vortex structures. At this point, light can be reinterpreted unambiguously within the Unified Theory.

In current physics, light is successfully described as an electromagnetic wave and, in the quantum regime, as a photon. These descriptions remain operational. They allow the calculation of propagation, interference, polarization, energy, and discrete transfer. Nevertheless, in the Unified Theory, these descriptions are not regarded as the ultimate image of the phenomenon. They are read as projections of a deeper geometrodynamic structure.

[H] The central hypothesis of this chapter is the following: at a level not yet formalized, light may have a helical-jet-type geometrodynamic substrate. Wave behavior should result from cyclicity, phase, and orientation, while corpuscular character should result from quantized local transfer. Until electromagnetic and quantum predictions are derived, this statement has the status of an ontological hypothesis, not a demonstrated result.

Likewise, passage of the jet through different media—for example, crystals—may adjust the flow parameters.

[H] Central formulation

Light-jet hypothesis: light is modeled as a coherent helical jet; the wave would represent the projection of its cyclicity, while the photon event would represent quantized local transfer. Physical validity depends on recovering the Maxwell–quantum electrodynamics (QED) formalism.

11.2. The standard description and its place in the Unified Theory

Classical electromagnetism treats light as the propagation of an electromagnetic field. Quantum mechanics treats the elementary exchange of light through the photon. These two descriptions are extremely effective experimentally and must not be discarded. A new theory does not become stronger by rejecting results that work, but by explaining them within a deeper framework.

Current physics — Maxwell's equations describe classical propagation, polarization, and interference, while quantum electrodynamics describes the quantized electromagnetic field, photons, emission, and absorption. Lorentz invariance, gauge symmetry, the speed c , the Born rule, and the relations $E=hf$ and $p=h/\lambda$ are mandatory experimental conditions. [1,2,16,17,32]

The theory's proposal — The helical jet is introduced as a possible common geometric substrate for directionality, phase, polarization, and localization of transfer. Its variables constitute a proposed kinematic scheme, not yet the variables of a derived electromagnetic field.

The missing bridge — The model must recover Maxwell's equations in the classical limit, Lorentz transformations, gauge freedom, propagation in vacuum without a material medium, energy quantization, and photon statistics. Without this bridge, the jet remains a conceptual reinterpretation.

[F] Test criterion — The model must reproduce Malus's law, single-photon interference, diffraction, elliptical polarization, photon momentum, and detection probabilities, and then identify at least one quantitative deviation from standard electrodynamics.

Under the Unified Theory hypothesis, the electric and magnetic fields should emerge as effective quantities derived from the state of the jet. This correspondence cannot be declared verbally alone: a mathematical mapping must be defined between the geometrodynamic variables and the electromagnetic tensor, so that frequency, wavelength, phase, and polarization acquire the same operational meaning as in experiments.

Therefore, the reinterpretation does not diminish current physics and cannot claim that it describes merely a 'shadow.' It proposes an additional ontology, acceptable only if it reproduces the same results and offers a new, measurable, and falsifiable prediction.

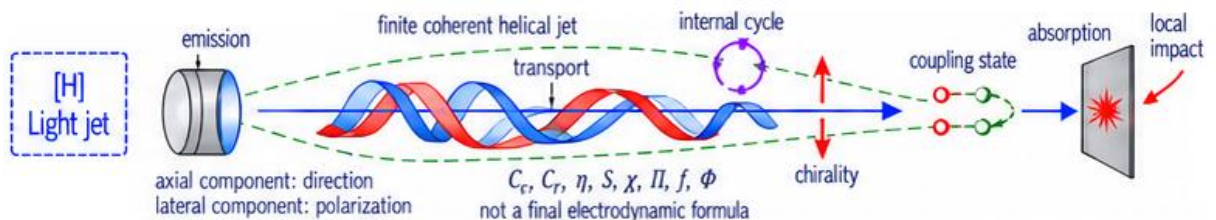
11.3. Geometrodynamic definition of light

Light is defined here as a coherent helical jet, emitted, transported, and absorbed as a finite structure. It has an axial direction, internal cyclicity, chirality, a lateral component, a coupling state, and a capacity for local impact. It is not a mere oscillation of an unsupported parameter, but an organized flow capable of producing wave effects when it interacts with the environment or with the measuring instrument.

$$J_L = J_a + J_l$$

In this notation, J_L denotes the light jet, J_a the dominant axial component, and J_l the lateral or transverse component. The axial component provides the transport direction, beam directionality, and arrow character. The lateral component provides the polarization orientation, whip character, transverse coupling, and the manner in which the jet may be filtered or deflected.

$$S_L = (C_c, C_r, \eta, S, \chi, \Pi, f, \Phi)$$



The hypothetical geometrodynamic state of a light jet may be denoted by S_L . It includes C_c , the rotational descriptor C_r , the ratio η , axial direction S , chirality χ , polarization orientation Π , frequency f , and phase Φ . This notation is a state scheme, not a final electrodynamic formula; α may be calculated later without being introduced as an independent variable.

11.4. The helical arrow — the axial regime of light

The first regime of light is the axial, helical-arrow regime. In this regime, the light jet has a dominant direction, high transport coherence, and a strong capacity for impact. It is an oriented structure, not a diffuse distribution. The image of a ray of light thus becomes the visible image of a helical arrow.

Coherent light, such as a laser beam, may be interpreted as a flock of parallel helical arrows. Coherence means not only the same frequency, but also alignment of axial direction, phase compatibility, coupling compatibility, and synchronization of the helical states.

$$L_{coh} = \{J_{a1}, J_{a2}, \dots, J_{an}\}$$

$$s_i \approx s_j, \alpha_i \approx \alpha_j, \Phi_i \approx \Phi_j$$

This formulation transforms the idea of coherent light into a geometrodynamical image: several parallel axial jets behave as a single ensemble because their states are synchronized. What physics describes as a coherent wavefront may be interpreted, within this framework, as the common front of a bundle of helical arrows.

11.5. The helical whip — the lateral regime and polarization

The second regime is the lateral, helical-whip regime. Here, concentrated axial transport is not expressed primarily; instead, the transverse component of the jet is expressed. It may oscillate, become oriented in a preferred plane, be filtered, and produce polarization effects.

The polarization of light thus acquires a direct geometric interpretation. It is not merely the oscillation of a field in a plane, but the dominant orientation of the lateral component of the helical jet. The plane of polarization is the plane in which the jet, like a whip, has freedom of displacement and coupling.

$$\Pi = \text{orientation of the lateral component } J_l$$

A polarizing filter should not be understood merely as a device that selects a wave. In this view, it is a material structure that allows the passage of those helical jets whose lateral components are compatible with the mechanical orientation of the filter.

$$I(\theta) = I_0 \cos^2\theta \text{ (Malus's law)}$$

Model requirement: $T(\theta) = \cos^2\theta$, not a pass/fail selection.

In this relation, θ is the angle between the incident polarization and the analyzer axis. Any geometrodynamical compatibility mechanism must produce continuous $\cos^2\theta$ transmission and explain absorption of the complementary energy; a binary threshold is incompatible with observation.

11.6. Unpolarized and polarized light

Unpolarized light may be understood as an ensemble of helical jets whose lateral components are distributed across many orientations. Polarized light appears when these lateral components are selected, aligned, or constrained within a dominant plane.

$$L_{nopol} = \Sigma J_L(\Pi_k), \Pi_k \text{ distributed across many planes}$$

$$L_{pol} = \Sigma J_L(\Pi_0), \Pi_k \approx \Pi_0$$

This distinction preserves the observations of current physics but moves them into the language of flow. Sunlight, for example, may be viewed as an accumulation of jets with varied lateral orientations. After passing through a filter, the remaining ensemble has a dominant lateral orientation. *In the language of the theory, the filter does not create polarized light; it selects a family of jets compatible with its own geometry.*

11.7. Frequency, wavelength, and phase

If light is a helical jet, then wave quantities must be reinterpreted as projections of the jet's cyclicity. Frequency expresses the rate of the internal cycles, but there is also a rate of the coherent succession of jets, or pulses. Wavelength expresses the projected axial distance between two equivalent states of the helical cycle. Phase expresses the internal position of the jet within its own cycle.

$$\lambda_{obs} = v_{obs} / f$$

$$\Phi = \text{relative position within the helical cycle}$$

The formula $\lambda_{\text{obs}} = v_{\text{obs}} / f$ remains operational. It does not, however, require the ontological interpretation of light as a wave without a substrate. In this theory, the formula describes the projected periodicity of the jet. In other words, wavelength is the distance at which the same cycle state becomes observable again along the direction of propagation.

This reinterpretation is important because it preserves the power of wave calculation while changing its status. The wave is no longer the ultimate object, but the projection of a cyclic helical flow.

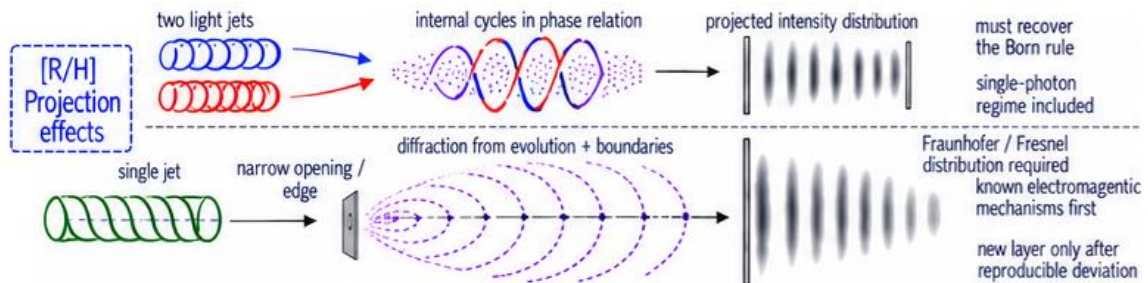
11.8. Interference and diffraction as projection effects

Interference does not require light to be only a wave. It shows that two or more light structures may enter into a phase relationship and produce intensity distributions. In the Unified Theory, this phase relationship is interpreted as a relationship between the internal cycles of the helical jets.

$$\Delta\Phi = n \cdot 2\pi \rightarrow \text{coupling maximum}$$

$$\Delta\Phi = (2n + 1) \cdot \pi \rightarrow \text{coupling minimum}$$

Interference maxima and minima are calculated conventionally by adding complex amplitudes and applying the Born rule. *The jet model must produce the same distribution, including in the single-photon regime; the expression 'projective cancellation' is only an image until the probability amplitude is derived.*



Diffraction can be formulated geometrodynamically only if the jet's evolution equation, together with the boundary conditions, generates the corresponding Fraunhofer/Fresnel distribution. The material and the edge may modify the result through known electromagnetic mechanisms; a new boundary layer is justified only by a reproducible deviation from them.

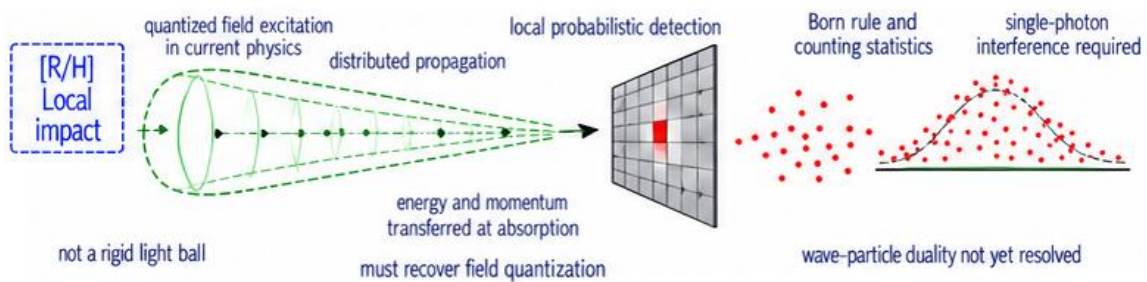
11.9. The photon as a local impact event

In quantum theory, the photon is the quantized excitation of the electromagnetic field, while detection is local and probabilistic. The Unified Theory may propose the jet's impact event as a geometric image, but localization of absorption is not sufficient: the model must recover field quantization, the Born rule, single-photon interference, and counting statistics.

$$E_{\text{obs}} = h \cdot f$$

$$p_{\text{obs}} = h / \lambda_{\text{obs}}$$

These relations remain operational relations of current physics. In the geometrodynamic reading, E_{obs} and p_{obs} do not describe a ball of light, but the energy and momentum transferred locally when the jet is absorbed or coupled to a receiving system. Discretization appears at the level of interaction and absorption, not necessarily as proof that light is ontologically a rigid particle.



This idea offers a possible unifying image of wave-particle duality, but does not yet resolve it. Reconciliation becomes physical only if the same jet dynamics produces both propagation amplitudes and the quantized probabilities of detection events.

11.10. The difference between light and F.T.W.

A clear separation is required between light as a helical jet and the Fundamental Torsion Wave. F.T.W. belongs to drift. It is the propagation of a perturbation, especially through a lateral C–C relationship, with an axial response in each affected filament. Light, by contrast, is an emitted, transported, and absorbed structure. *It is not merely a transmitted deformation, but an organized jet.*

F.T.W. = perturbation + lateral drift + internal axial response

Light = emitted helical jet + coherent transport + local absorption

[H] In the model, F.T.W. may modify geometry without the emission of a light structure, while light may produce drifts and perturbations without being reducible to F.T.W. The image of a ‘deformation signal’ versus an ‘emitted jet’ is heuristic. Extending the same scheme to all radiation is a programmatic hypothesis and becomes a physical claim only after recovery of electromagnetic and quantum theories and after distinct experimental predictions.

11.11. The kernels of light

Light does not introduce a new kernel. It must be described through the already defined kernels. The axial regime is linked to axial decoupling or continuity, close to M–C behavior. The lateral regime is linked to the C–C component, where polarization, filtering, deflection, and interaction with neighboring structures become dominant. The toroidal regime may appear in local conversions, absorptions, closures, or re-emissions around T–C-type structures.

Regime	Associated kernel	Geometrodynamical meaning
Axial arrow (emission)	M–C / axial decoupling	directional jet, beam, concentrated impact
Lateral whip (emission)	C–C / lateral component	polarization, filtering, deflection, transverse coupling
Local conversion	T–C	closure, local rotation, absorption or re-emission
Loading/unloading	C–A	relationship with the attractor, source or receiver

This tabulation does not transform the kernels into classical optical phenomena. It shows only how light, within the Unified Theory, can be placed in the fundamental system already introduced. Light is a case of emission, transport, filtering, and absorption of a helical structure.

11.12. Light, polarization, and oriented information

Chapter 8 established that axial direction and chirality are oriented state information. In the case of light, polarization adds further oriented information: the jet's dominant lateral direction, the plane of motion of the whip. In the case of the arrow, polarization is regarded as circular around the axis. Therefore, a light beam carries not only energy, but also a coupling geometry.

$$I_L = (S, \chi, \Pi, \eta, \Phi)$$

I_L denotes the proposed oriented information of the light jet. It includes axial direction, chirality, the dominant lateral plane, the ratio η , and phase. Under the model's hypothesis, these components influence transmission, reflection, absorption, or deflection; a dynamical law must still quantify the outcome.

From this perspective, polarization is not an ornament of light, but a property of class and interaction. An optical medium interacts not only with light's energy, but also with its geometrodynamical orientation.

11.13. What this reinterpretation explains and does not yet explain

This chapter formulates a geometrodynamical interpretation, not a fully completed optical theory. It does not yet replace Maxwell's equations, quantum field theory, or quantum electrodynamics. These theories remain the standard tools for calculating optical phenomena. The Unified Theory nevertheless proposes a deeper level of interpretation: all these results may be viewed as operational descriptions of the projections and interactions of a helical jet.

The strength of the chapter lies not in denying current optics, but in organizing the concepts. Wave, particle, polarization, coherence, interference, and absorption no longer appear as separate properties that are difficult to reconcile. They become different effects of the same structure: the helical jet.

For this interpretation to become a complete physical model, it must be developed further: propagation conditions, rules of interaction with optical media, criteria for absorption and emission, and mathematical correspondences with established equations must be formulated. In this volume, its role is to show the place of light within the architecture of the theory.

11.14. Conclusion — light as the first major application of vortex emission/absorption

Light is the first domain in which the Unified Theory hypothetically applies the mechanism of structural emission, transport, and absorption. The separation from F.T.W. and the arrow/whip regimes are elements of the proposed model, not optical results already derived.

The wave is the projection of its cyclicity. The photon is the local event of its impact. Polarization is the orientation of its lateral component. Coherence is the synchronization of an ensemble of compatible jets. Interference is the phase relationship between their cycles. Diffraction is the reconfiguration of their projection upon encountering an edge, slit, or separating structure.

If the same dynamics recovers wave propagation and quantized detection, the helical jet could offer a common image of the two regimes. Until then, duality is reformulated conceptually, not resolved physically.

[H] Hypothesis of light as a helical jet

The Unified Theory postulates that light may be modeled as a coherent helical jet with an axial regime and a lateral component. Wave character and the photon event are proposed correspondences; they become explanations only after deriving the Maxwell and QED limits and after confirming a differential prediction.

PART III · ORGANIZATION, SELECTION, AND ARCHITECTURE

12. Geometrodynamical Darwinism — selection through stability and the hypothesis of heredity

12.1. From conservation to selection

The preceding chapters introduced a principle that can no longer be treated as a mere local property: a coherent helical flow survives not through rigidity, but through adaptation. It may modify its radius, pitch, internal distribution, orientation, roots and branches, or coupling state, but only insofar as it can conserve its geometrodynamical identity. This identity is not given by its instantaneous form, but by the relationships preserved during transformation.

In the Unified Theory, these relationships are described through the independent vector, measurement of the Preda triplet, and relational geometry. α may serve as a derived scalar diagnostic, while its role in coupling remains hypothetical. A coherent system is a state that maintains itself over time through successive corrections, as long as it can transform environmental stress into geometric adaptation.

But this adaptation has a limit. Not every perturbation can be absorbed. Not every encounter can be integrated. Not every coupling can become coherent. *When the system can no longer conserve simultaneously the constants that define its state, it enters decoherence. The old form can no longer continue as an identity. At that point, selection appears.*

Geometrodynamical Darwinism is the proposed name for the selection of configurations through coherence. In the form demonstrated conceptually here, the mechanism describes differential persistence through stability. It becomes Darwinism in the full sense only if variation, heredity, replication with finite fidelity, and differential reproduction of states are demonstrated.

Current physics and biology — Dynamic stability may select persistent configurations, but Darwinian evolution requires populations of replicators, heritable variation, and differential reproductive success. The persistence of a single structure is not equivalent to natural selection. [25–27]

The theory's proposal — *The flow-state vector is treated as a possible physical substrate of memory, and the C–C kernel as a candidate mechanism for inducing related states. The terms ‘genome,’ ‘mutation,’ and ‘species’ are operational analogies.*

The missing bridge — A replication operator must be defined that produces distinct entities, together with a fidelity metric, an inheritance rule, and a reproduction rate dependent on state and environment.

[F] Test criterion — In repeated C–C experiments, the induced state must reproducibly inherit the components of the independent vector, variations must persist into a subsequent generation, and certain variants must multiply differentially under the same stress.

Selection through persistence may also be defined outside biology, but the term ‘Darwinian’ requires more than mere stability. In the model, an open system may pass among adaptation, decoherence, and reconfiguration; a complete Darwinian analogy can be supported only if replication, heritable variation, and differential reproduction are demonstrated.

From this perspective, the Universe is not a collection of finite objects, but a succession of selected geometrodynamical states. What persists is not matter as inert mass, but the coherence capable of organizing matter. A form that cannot conserve transport disappears as a system, even if the material from which it was composed continues to exist in other configurations.

[H] The central hypothesis of the chapter is:

Geometrodynamical Darwinism is the hypothesis according to which certain coherent helical flows are maintained, replicated, or eliminated according to their capacity to preserve the independent state vector and interact with the environment. α is a derived diagnostic, not an independent selection criterion.

This definition shifts the emphasis from survival of form to survival of state. The visible form may vary; the conserved state is what allows the system to remain the same. When the state can no longer be conserved, the system is no longer the same, even if part of its form appears to continue.

12.2. Geometrodynamical memory as the object of selection

In biology, selection acts on organisms and, indirectly, on the hereditary information that enables them to reproduce. In the Unified Theory, selection acts on geometrodynamical memory. This memory is not symbolic, is not written in an alphabet external to the system, and is not stored in a separate substrate. *It is inscribed in the mode of flow.*

A coherent flow can carry physical memory if its states are distinguishable, persistent, and recoverable through measurement. The values of the constants become information only in relation to a physical code of discrimination and a mechanism of transmission; mere conservation of a quantity does not by itself demonstrate information encoding.

We may denote the minimum memory of a flow by:

$$C_P = (C_c, C_f, C_e)$$

where C_c expresses variation in transport, C_f expresses the kinematic form, and C_e expresses the internal rotational cycle. The triplet must not be understood as an abstract collection of numbers or as three independent degrees of freedom, but as an operational reporting set. If the system preserves its constraints, state memory continues; if it does not, the former state ends.

The state relation combines the quantities into a derived dimensionless number to which the theory hypothetically assigns the role of a scalar filter:

$$\alpha = \frac{C_e \cdot C_f}{C_c^2}$$

or, equivalently:

$$\alpha C_c^2 = C_e \cdot C_f$$

Within the hypothesis of geometrodynamical Darwinism, preserving form is not sufficient: the flow must conserve the independent components of the state. α is then preserved algebraically. The assertion that exceeding an α tolerance changes the interaction remains a separate hypothesis that must be compared with the prediction obtained directly from C_c , C_r , η , orientation, and phase.

In this sense, the state vector may analogically be called a 'geometric genome' only if its values are copied with measurable fidelity into a distinct structure. Until such transmission is demonstrated, it represents a state signature, not a genome in the biological sense.

Selection, within this hypothetical framework, favors the state capable of preserving its memory under stress. A structure incapable of adaptation loses coherence, while one that maintains (C_c , C_r , η , S , χ , ϕ) within the stated tolerances may persist. C_f and C_e verify rotation through distinct pathways, while α is recalculated from the Preda quantities.

In the Unified Theory, memory is not what the system remembers, but what the system can conserve while it transforms.

12.3. Geometric stress and environmental pressure

No real system evolves in an absolute vacuum of interaction. Every coherent flow is exposed to potential differences, vortex neighborhoods, material boundaries, stratified fields, absorption, emission, braking, deflection, and lateral couplings. *The environment is not a backdrop, but an agent of stress.*

In the Unified Theory, this stress may be called geometric stress. It arises when the state required by the environment does not coincide with the flow's own state. The system is forced to decide geometrodynamically: it adapts, decouples, absorbs, emits, branches, polarizes, or disintegrates.

Geometric stress may be small, local, and reversible. It then produces only F.T.W.-type deviations, namely lateral deformations transmitted through neighboring flows. It may be moderate, in which case the system changes its form while preserving its identity. It may be large, in which case abrupt adaptation occurs: emission, absorption, decoupling, or detachment of branches. Finally, it may be critical, in which case the old state can no longer continue.

We may express the principle as follows:

coherence $\Leftrightarrow$ conservation of the independent components (C_c , C_r , η , S , χ , ϕ)

decoherence $\Leftrightarrow$ departure of the independent components from the coherent-state domain

This distinction transforms geometric stress into a selection mechanism. The environment does not select intentionally. It needs no purpose. It selects through incompatibility. Compatible flows find a geometry of survival; incompatible flows lose continuity of state.

At this point, geometrodynamical Darwinism becomes distinct from mere mechanical stability. A system may be temporarily stable but evolutionarily dead if it cannot respond to change. Conversely, a system may be permanently deformable but evolutionarily alive if its deformations preserve its memory. *Adaptability becomes more important than immobility.*

This idea is decisive for understanding nature. Absolute stability is not the sign of the physical life of a system. A completely rigid structure does not adapt. It resists until it breaks. A coherent structure, by contrast, flows, partially reconfigures itself, redistributes its stress, changes its local relationships, and preserves only what is essential to identity.

Therefore, geometrodynamical selection favors not rigidity, but adaptive coherence.

12.4. Continuous adaptation, abrupt adaptation, and the death of a state

Geometrodynamical evolution has at least three stages. The first is continuous adaptation. The second is abrupt adaptation. The third is the irreversible decoherence of a state.

Continuous adaptation occurs when the system can compensate for stress through fine changes in geometry. The helix pitch changes, the radius changes, the axis bends, and axial and tangential velocities are redistributed. The system does not necessarily emit structure, absorb roots and branches, or radically change its organization. It adjusts.

Abrupt adaptation occurs when adjustment is no longer sufficient. The system must then modify its structural load: it may decouple a root or branch, emit a helical jet, absorb a vortex, detach a peripheral layer, or break an internal bond. In this regime, the system no longer corrects only its form; it changes its architecture.

Decoherence occurs when neither continuous nor abrupt adaptation can preserve the former state. At that moment, the system ceases to be the same. Matter, energy, momentum, or information do not necessarily disappear; what disappears is the geometrodynamical identity of the former flow.

This is the death of a state.

Death, in the geometrodynamic sense, is not the disappearance of substance, but the loss of the coherence that allowed a structure to be recognized as a system. A tornado that dissipates does not annihilate the air. A vortex that breaks does not annihilate the medium. A particle that transforms does not annihilate its state content. But the former configuration can no longer continue as an identity.

From this perspective, every system has a life cycle: emergence, stabilization, stress, adaptation, limit, decoherence, and reconfiguration. This cycle may be short or long, simple or branched, local or cosmic. What matters is that the life of a state is measured not only by duration, but by its capacity to preserve memory under transformation.

Geometrodynamics Darwinism does not say that everything survives. It says that everything that survives as a system has passed through a compatibility filter. Coherent existence is already the result of selection.

12.5. Reconfiguration and geometrodynamics mutation

After decoherence, the system does not simply return to its previous state. If the former memory can no longer be preserved, another state may form, with different constants, another mode of coupling, another chirality, another axial direction, and another internal distribution. This is reconfiguration.

Reconfiguration is the moment when the old identity is lost, but the flow material remains available for a new organization. In evolutionary terms, this is the moment of geometrodynamics mutation.

We may express the transformation as follows:

$$\mathcal{S}\chi_{\text{ind}} = (\mathbf{C}_c, \mathbf{C}_r, \boldsymbol{\eta}, \mathbf{S}, \boldsymbol{\chi}, \boldsymbol{\varphi})$$

$$\mathcal{S}\chi \rightarrow \mathcal{S}\chi'$$

This transition is not a mere continuous variation of the same state. It is the emergence of a new state. It may preserve fragments, orientations, roots, branches, or values close to the old state, but it is no longer identical to it. The new system has different information.

In biology, mutation is a change in hereditary information. In the Unified Theory, geometrodynamics mutation is a change in the values of the set of constants and in state compatibility after decoherence or critical reconfiguration. Not all mutations are viable. Most reconfigurations may be unstable, transient, or incompatible with the environment. Only some stabilize.

Here selection through stability appears: reconfiguration produces variation, and the environment differentiates the persistence of states. Darwinian selection proper appears only if the variation is transmitted to replicas and modifies their reproductive success.

This sequence may be written conceptually as follows:

state variation → coupling test → adaptation or decoherence → preservation or reconfiguration

This formulation contains an analogy with biological evolution, but not yet a demonstrated generalization. *A system can evolve in a Darwinian manner only if physical memory is transmitted, variation is heritable, and differences of state produce different replication rates; adaptation without replication remains selective dynamics, not complete Darwinism.*

Geometrodynamics mutation is therefore a change of information in the memory of the flow. It is not a cosmetic deformation. It is the birth of another possibility of coherence.

12.6. Kernels as evolutionary mechanisms

Kernels are, at the present stage, schematic modes of interaction and candidates for evolutionary operations. To become evolutionary mechanisms, each must be supplied with evolution equations, input/output conditions, and reproducible outcomes.

The kernel C–A, cylinder–attractor, has a generative function. It describes how a potential difference may initiate an axial flow, orient accumulation, and produce the first axis of organization. Evolutionarily, C–A is the gateway of emergence. Without a capture region, a potential difference, and an initial direction, there is no beginning of a coherent state.

The kernel M–C, multiple–cylinder, has a function of axial continuity. It enables chaining, extension, formation of threads, and continuity of transport. Evolutionarily, M–C preserves the line. It does not necessarily produce diversification, but continuity. Wherever a flow must be maintained over a long direction, the axial kernel becomes fundamental.

The kernel C–C, cylinder–cylinder, hypothetically describes lateral induction, adjacency, and aggregation. It is a candidate for replication only if a flow produces a distinct structure that measurably preserves state information and can in turn induce another structure. A mere bundle or an increase in thickness does not constitute reproduction.

The kernel T–C, torus–cylinder, has a function of perpendicular induction and field organization. It enables the appearance of rings, mantles, layers, capture zones, and closure structures. Evolutionarily, T–C enables the transition from thread to field, from linear transport to a surrounding structure, and from axis to layer.

Together, the kernels form a set of evolutionary operations:

- **C–A initiates.**
- **M–C continues.**
- **C–C multiplies and aggregates, stratifying antichirally.**
- **T–C closes, stratifies, and organizes perpendicularly and chirally.**

This evolutionary reading is important. It shows that, at the present stage, the minimal formal scheme functions as a grammar of transformation. From the hypothetical composition of the kernels, higher-order forms may be modeled: nodes, conglomerates, trees, layers, jets, polarizations, clusters, and regimes of axialization.

Geometrodynamical Darwinism begins where the kernels are no longer isolated events, but are repeated, combined, and selected by coherence.

12.7. C–C replication and the transmission of information

Among all the kernels, C–C has special importance for the idea of evolution. It describes the lateral interaction between two cylindrical antichiral helical flows. In this regime, the flows may remain distinct while influencing and aligning with one another, inducing one another, or forming coherent bundles.

Geometrodynamical replication must not be understood as the mechanical copying of an external form. It is the transmission of a mirrored flow state to a neighboring region. A flow does not reproduce its reflected image, but the conditions through which another flow may enter a compatible regime.

This is a proposed difference from the biological analogy. In the Unified Theory, C–C replication would copy or induce flow information. If the values (C_c , C_r , η , S , χ , ϕ) are reproduced within tolerance limits, the new flow may belong to the same geometrodynamical family; the criterion must be tested experimentally.

C–C replication may be incomplete, imperfect, or unstable. This is precisely why it produces variation. Perfect replication would generate only repetition. Partial replication creates the possibility of evolution. If the difference is tolerable, coherent variation appears. If it is too great, decoherence occurs.

[H] C–C is the model's candidate for a prototype of geometrodynamical replication. It could produce similar mirrored flows with different variations and persistence. The designation 'Darwinian' is justified only if distinct descendants, measurable fidelity, inheritance over multiple generations, and differential reproduction appear; until then, the correct description is selection through stability.

C–C also explains the transition from individual to collective. A single flow may have its own memory. A bundle of compatible flows may have distributed memory. When a perturbation of one branch is transmitted to the others, the system is no longer a sum of vortices, but an ensemble with shared coherence.

This hypothesis will be revisited in the chapters on cluster polarization, tree architecture, and kinematic correlation. For now, C–C is proposed as the mechanism by which a local state might become part of a collective memory, if replication and fidelity are confirmed operationally.

12.8. Chirality and selection through compatibility

No theory of helical flows can avoid chirality. A vortex has not only an axis and a direction of transport, but also a winding orientation. This orientation is not a decorative detail. It determines what may couple, what repels, what chains together, and what aggregates.

In the Unified Theory, chirality must be treated as a criterion of evolutionary compatibility. Two flows may have close constants but incompatible chiralities. Their coupling may then become unstable.

Conversely, two flows may have local differences of form, yet sufficient chiral compatibility to align, replicate, or integrate into a bundle.

From this perspective, fermionic behavior and bosonic behavior may be read as two major modes of organizing chirality.

The fermionic, natively monochiral regime is associated with axial continuity, the chain, the end-to-end relationship, the long thread, and distinct identity. It does not seek complete lateral superposition, but continuity along the direction. In simple language, *fermionic flows chain together*.

The bosonic, natively bichiral regime is associated with lateral aggregation, the bundle, compatible adjacency, and the collective state. It does not insist at all on separate individuality, but on lateral synchronization. In simple language, *bosonic flows gather into a bouquet*.

This distinction must be preserved for the following chapters. The polarization of conglomerates of helical flows will not be understandable without it. A node (*cluster*) receives flows with different directions, classes, and chiralities. According to the dominant behavior, it may organize fermionic outputs, bosonic outputs, layers, bundles, or single transport axes.

Chirality therefore introduces an additional filter into geometrodynamical selection. It is not only the flow with sufficient energy or stable form that survives. The flow capable of coupling chirally with its environment survives. This may be formulated as follows:

Proposed compatibility:

$$\mathcal{D}[\mathcal{S}(i), \mathcal{S}(j)] \leq \varepsilon$$

+ **relative contact geometry + dynamic stability of the interaction**

α may be reported as an auxiliary quantity, not as an independent axis. In the absence of chiral compatibility, the system may remain energetically possible but geometrodynamically impossible.

12.9. Nodes, conglomerates, and directional selection

In nature, helical flows rarely remain singular systems. They meet, gather, branch, separate, absorb, reflect, and reorient. *At points or regions where several vortex tubes enter and leave, vortex nodes and conglomerates appear.*

A node is not merely a place of passage. It is a region of geometrodynamical decision. Different flows enter it; only those flows that can be redistributed into a compatible state emerge from it. The node selects directions, classes, chiralities, and modes of coupling.

In such a node, the proposed selection also becomes orientation: a flow may be accepted along one direction, deflected, partially absorbed, or included in a layer. The model calls the oriented grouping of vortex tubes ‘polarization of the conglomerate.’ The term is not identical to the electromagnetic polarization of light; the two concepts should be correlated only if a derivation demonstrates a physical correspondence.

Polarization must not be confused with simple optical polarization. In the broad geometrodynamical sense, polarization is the ordering of a node's inputs and outputs by compatibility. A polarized conglomerate is not merely an accumulation of vortices, but a structure that knows, through its own geometry, how to receive and emit.

This chapter does not yet develop the four types of polarization in detail, but prepares them. Within the structure of the volume, they must be treated separately because they represent an important component that must not be lost. Nodes may have **POL-1**, **POL-2**, **POL-A** or **POL-B** polarization, according to the classes of flows, the bosonic or fermionic regime, and the distribution of inputs and outputs.

In particular, POL-B polarization must be retained as the only stratified polarization. It may be understood as a node or conglomerate wrapped in successive layers of flows, where selection occurs not only through the axis, but also through shells, mantles, and zones of compatibility at different distances.

This idea will become important for interpreting material edges, fringes, the stratification of edge fields, and the interaction of photon jets with surfaces. If a material has a stratified field organization around its edge, each photon species may react selectively with other layers. The fringes could be read as projections of this stratified selection.

Therefore, geometrodynamical Darwinism selects not only structures. It also selects directions, outputs, layers, and modes of polarization.

12.10. Layers as peripheral memory

A coherent structure does not carry its memory only along the axis. In many cases, memory is also distributed peripherally, in layers, mantles, rings, marginal branches, or transition fields. This idea is essential if the helical flow is not to be reduced to a simple axial thread.

The axis provides continuity. The periphery provides interaction. The layers provide selection at a distance.

A vortex conglomerate may have a coherent core and outer layers with different degrees of compatibility. A flow that penetrates near the core encounters a strong coupling regime. A flow that passes through the periphery encounters a weak or intermediate regime. Between these regions there may be thresholds, jump zones, reorientations, and differentiations.

In this sense, the layers of a vortex tube are not mere ornaments made of vortex lines around the system. They are peripheral memory. They preserve information about how the system interacts with the exterior. They determine what enters, what leaves, what is reflected, what is absorbed, and what is reoriented.

This idea may be applied at many scales. Planetary rings may be read as a macroscopic image of dynamic stratification, in which particles occupy preferred regions of orbital compatibility. At another scale, the boundary layers of a material may be read as compatibility zones for photon jets. In both cases, what appears to be a continuous field is organized into bands, thresholds, and regions of stability. At the atomic or even subatomic level, stratified outer shells might select only compatible interactions that confer stability.

In the Unified Theory, stratification becomes a general principle:

field + cyclicity + compatibility = stable layers

This relation is not a calculation equation, but an interpretive scheme. It shows that where cyclic motion exists within a constraining field, the distribution does not necessarily remain uniform. It may organize into layers, and those layers may become a substrate of selection.

Geometrodynamics Darwinism must therefore be extended from selection of the core to selection of the periphery, to the shell formed by layers. A system evolves not only through what it preserves at its center, but also through what it permits at its edge.

12.11. From the physics of selection to the biology of selection

Such a theory must not confuse levels. Biological evolution remains a domain in its own right, with molecular, genetic, cellular, ecological, and historical mechanisms. It is neither necessary nor correct to reduce biology to simple vortices. Nevertheless, the Unified Theory proposes that certain physical conditions of evolution are more general than biology.

For selection to appear, several minimal elements are required: memory, information, interaction with the environment, variation, a compatibility criterion, and a capacity for transmission. In biology, these elements appear through molecules, cells, and reproduction. In geometrodynamics, they appear through constants, their values, reconfigurations, kernels, and state replication.

This parallel does not say that a vortex is an organism. It says that an organism may be understood as an extremely advanced architecture of more general principles: flow, memory, information, adaptation, polarization, selection, and reconfiguration.

Here the profound connection with life appears. Life is not only chemistry, although it is expressed chemically. Life is the capacity of a system to preserve value-information in an operational memory while situated in an environment that changes it continuously. From this perspective, biology does not begin with inert matter that suddenly becomes alive, but with physical organizations capable of preserving and transmitting state.

The Unified Theory does not replace biology. It seeks the geometrodynamics background that makes biology possible. If prebiotic molecules were able to become self-replicating systems, this did not occur in an abstract space, but in an environment with flows, surfaces, edges, layers, vortices, potential differences, and local selections of compatibility.

Within this framework, could biological evolution be deduced from geometrodynamics Darwinism? The hypothesis may be formulated that selection through stability provides a physical background favorable to the emergence of chemical replicators, while natural selection remains the specific biological mechanism of hereditary populations.

12.12. Coherence, information, and loss of identity

The most important result of this chapter is the separation between material and identity. Matter may continue after the disintegration of a system. Energy may be redistributed. Momentum may be transferred. But geometrodynamical identity disappears when state memory can no longer be conserved.

This distinction changes how we view destruction, transformation, and emergence. When a flow enters decoherence, not everything that existed within it disappears. Only the form of coherence that allowed it to function as a system disappears. *When a new flow emerges, it does not emerge from absolute nothingness, but from the reorganization of an available state under different conditions.*

Thus, the Universe may be read as a succession of geometrodynamical memories: some are preserved, others break, others replicate, others stratify, others polarize, and others transform into tree-like architectures. Evolution is not an accident added to matter, but the manner in which self-organized matter tests its possibilities of coherence.

At the present stage, geometrodynamical Darwinism remains a structured analogy and an experimental program. Selection through stability may precede biology; Darwinian evolution appears only after hereditary transmission and differential replication are demonstrated.

Biological Darwinism says: organisms better adapted to their environment survive.

Geometrodynamical Darwinism says: flow states capable of conserving a coherent memory under environmental pressure persist.

This formulation prepares the following chapters. If selection exists, there must be classes of flows subjected to selection. Hence the need for a taxonomy of helical flows. If classes exist, the way they polarize in nodes and conglomerates must be analyzed. If polarized nodes exist, tree architecture must be understood. And if a coherent tree exists, kinematic correlation becomes the distributed reaction of the entire structure.

The conclusion of the chapter may be formulated as follows:

[H] *The hypothesis of geometrodynamical selection states that states capable of adapting their geometry may extend their persistence, while incompatible states reconfigure. The designation Darwinism becomes justified only after replication, heredity, and differential persistence are demonstrated in a population of flows.*

13. Taxonomy of helical flows — classes, species, and geometrodynamical identity

13.1. From selection to classification

The preceding chapter introduced geometrodynamical Darwinism as a general mechanism for the selection of coherent flows. A helical flow persists only if it can conserve its internal memory, adapt its geometry to the environment, and remain compatible with the interactions that stress it. When these conditions can no longer be met, the flow enters decoherence, and the matter, energy, and information it carried are reconfigured into another state.

Darwinism, however, is not sufficient without taxonomy. If nature selects flows, there must be criteria by which those flows can be distinguished. If some structures are conserved, others replicate, others aggregate, and still others cease, then each must be recognizable through an identity of its own. This chapter introduces that order: the taxonomy of helical flows.

In biology, taxonomy is not reduced to names. It orders organisms by criteria of relationship, structure, function, and evolution. In the Unified Theory, the taxonomy of helical flows has a similar role, but operates at the geometrodynamical level. It does not classify solid objects, but flow states. It does not classify frozen forms, but kinematic identities. It asks not only what a flow looks like, but what memory it has, what transport it can sustain, what coupling it accepts, what chirality it permits, and what kind of evolution it may undergo.

Current physics — Flow regimes are classified through equations, dimensionless numbers, stability, and observables; fermions and bosons are defined through spin and quantum statistics, not through axial or lateral geometry.

The theory's proposal — The taxonomy uses the independent vector, chirality, phase, relative geometry, and kernel history to group flow states. The terms fermionic and bosonic appear only as later analogies for restriction and collectivity.

The missing bridge — The classes must be identified in data through parameter domains, membership criteria, and measurable transitions. A correspondence with quantum particles would require deriving spin, statistics, and charges.

[F] Test criterion — A set of controlled flows must be classified unambiguously from measurements, and the assigned class must predict an interaction or transition on new data better than standard fluid parameters.

This transition is mandatory. Without taxonomy, all flows would remain generically named vortices, vortex tubes, or helices. But the Unified Theory cannot remain at this level. A tornado, a filament, a bundle, a branch, an induced flow, a replicated flow, or a stratified flow may share the same intuitive helical geometry while possessing different geometrodynamic identities. The criterion of differentiation is not the image, but the internal state.

Darwinism selects; taxonomy recognizes what has been selected.

For this reason, the taxonomy of helical flows is not an exercise in naming, but a necessary stage of the theory. It constructs the language through which the following chapters will be able to describe the polarization of nodes, tree architecture, kinematic correlation, axialization, and the Σ_{gd} regime of genesis. Without a taxonomy, nodes would not know what they receive, trees would not know what they distribute, and kinematic correlation would not know what it correlates.

13.2. Why the taxonomy of flows cannot be visual

The first temptation is classification by visible form. A straight flow would belong to one class, a curved flow to another, a branched flow to another, and a toroidal flow to yet another. This classification may be useful as a preliminary description, but it is insufficient. In the Unified Theory, the same flow may change its radius, pitch, torsion, curvature, number of roots/branches, and apparent form without losing its identity. On the contrary, geometric adaptation is precisely the mechanism by which identity is conserved.

If form can change to preserve the internal state, then form cannot be the primary criterion of taxonomy. It is expression, not foundation. A coherent vortex tube may become thinner, lengthen, curve, branch, or regroup, yet remain the same flow as long as it conserves its fundamental constants and state compatibility. Conversely, two flows that look almost identical may be incompatible if they possess different values of the constants, α , axial direction, or chirality.

Here the methodological reversal occurs. *Taxonomy does not begin with the image, but with state information. The image becomes a consequence of a class, not its absolute criterion. Visible geometry helps, but does not decide alone. A flow may have a cylindrical form and yet be primary, induced, replicated, or undergoing decoherence. A flow may have a toroidal form and yet be only a transitional stage, an induction node, a polarization layer, or a reorientation region.*

This distinction protects the theory from a common error: confusing projection with structure. In nature, what is seen is a section, a shadow, a temporary image of a process. *Taxonomy must classify the process, not merely its shadow.*

geometrodynamic class $\neq$ instantaneous geometric image

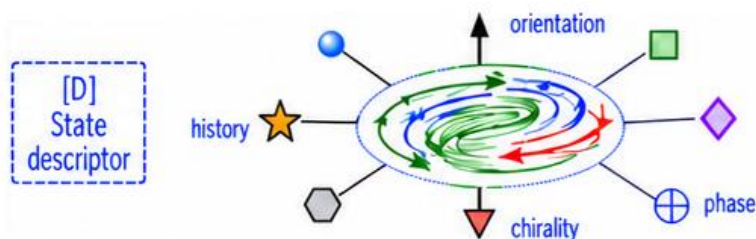
A geometrodynamic class is defined by what is conserved during transformation. It must include geometry, but cannot be reduced to geometry. It must include topology, but cannot be reduced to topology. It must include interaction, but cannot be reduced to the active kernel at a single moment. The class is the identity that persists through all these variations.

13.3. The extended geometrodynamic state

The preceding chapters introduced the operational Preda triplet and the derived state relation. For taxonomy, independent information is represented by C_c , the rotational **descriptor** C_r , the ratio η , axial direction S , chirality χ , phase ϕ , and kernel history. The number α may be reported as an auxiliary quantity, but is not an independent coordinate of the state.

$$\mathcal{S}\chi_{\text{ind}} = (C_c, C_r, \eta, S, \chi, \phi, X\chi, K)$$

In this formula, C_c describes flow-rate variation, C_r is the independent rotational descriptor determined through C_f or C_e , η describes the axial–tangential ratio, S is axial direction, χ is effective chirality, ϕ is phase, $X\chi$ is the permitted chiral class, and K is the dominant kernel or kernel history. The number α is calculated from C_c and C_r and is tested only as a hypothetical scalar filter.



This proposed extended state retains intensity, orientation, chirality, phase, and history. Axial direction is necessary for defining chirality, while the kernel describes the schematic class of interaction. The number α does not establish the engagement mode; it remains a derived scalar diagnostic whose usefulness must be tested separately.

The minimal taxonomy may be formulated as follows: two flows belong to the same geometrodynamical class if they possess the same state structure within the compatibility limits imposed by the theory of coherent flows. Two flows belong to the same species if, in addition to sharing the same class, they can interact, replicate, or continue without losing state identity. Two flows belong to the same subspecies if their differences are only local adaptations of the same identity.

class identity $\Rightarrow$ compatibility ($C_c, C_r, \eta, S, \chi, \phi, X\chi$)

species identity $\Rightarrow$ class compatibility + coupling compatibility through K

This order avoids confusion. A class is broader than a species. A species is more stable than a visual family. A subspecies is the local adaptation of a species to the environment. An individual state is a concrete instance at one moment of its geometrodynamical cycle.

13.4. The Preda triplet as primary identity

The first taxonomic stage is measurement of the Preda triplet. A coherent flow must preserve its transport variation and rotational constraint within the stated domain; its complete helical character is specified separately through η , direction, and chirality. If the independent vector leaves the tolerance of the class, the flow no longer represents the same geometrodynamical state.

C_c expresses the controlled variation of transport. C_f expresses the kinematic form through tangential velocity, while C_e expresses the same rotational level through cycle frequency. Loss of the common constraint $C_f = 4\pi^2 C_e$ means either that the measurements do not refer to the same local rotation or that the state has left the model's domain; complete helical character additionally requires η , direction, and chirality.

This triplet is analogous to a primary signature. Two flows may have different diameters, *velocities*, or *lengths*, yet may belong to the same family if they preserve the same state triplet in the geometrodynamical sense. Conversely, two flows may have the same visible form and still belong to different classes if their triplets differ.

$$C_P = (C_c, C_f, C_e)$$

C_P remains the operational reporting set for geometrodynamical identity, but the minimal taxonomic vector uses only C_c and C_r from this set. Their conservation, together with η , axial direction, chirality, and phase, allows the state to be recognized during adaptation; a persistent change in one component may indicate transition to another class.

Taxonomy therefore begins with the question: what triplet does the flow conserve? Only then may one ask what form it has, which kernel activates it, or what observable effect it produces.

13.5. α as a hypothetical taxonomic diagnostic

The second stage is the α diagnostic. It shows how C_e , C_f and C_c are related, but this information is already determined by the independent components. Therefore, α does not define an additional taxonomic axis; the theory tests only whether the proximity of its values usefully identifies candidate interaction families.

$$\alpha = \frac{C_e \cdot C_f}{C_c^2}$$

In taxonomy, α has only a hypothetical diagnostic role. Its equality or proximity may propose a scalar family of candidates, but classification is made through the independent vector and the kernel. A difference in α does not by itself prove coupling failure, nor does equality guarantee it.

A candidate interaction family is an ensemble of flows that can remain coherent after contact. Similarity of α may be used only as a preliminary filter; coupling must be decided from the independent vector, relative geometry, phase, and interaction dynamics.

candidate scalar family $\Rightarrow \alpha_i \approx \alpha_j$ (hypothesis)

Nevertheless, α is not sufficient. The preceding chapters showed that axial direction and chirality may prevent an otherwise possible coupling. For this reason, taxonomy cannot stop at α . It must continue toward orientation and chiral class.

13.6. Axial direction and chirality

A helical flow is not merely rotation. It is rotation oriented along an axis. *To define chirality correctly, the axial direction of the flow must first be established.* Only after choosing the direction of transport can one state whether the winding is right-handed or left-handed. This specification is fundamental because two flows with the same geometric image may become functionally different if the axial direction is reversed.

Axial direction, denoted S , establishes the functional IN–path–OUT direction. It is not merely the orientation of an arrow drawn on an axis. It indicates where the flow is loaded, where it transports, and where it unloads. In a tree structure, axial direction determines what is root, trunk, or branch; in a polarized node, it determines which inputs and outputs are activated.

Chirality, denoted χ , establishes the direction of winding relative to this axial direction. It is oriented information. It is not merely a geometric sign, but a compatibility criterion. Two flows may have the same α and the same order of magnitude of their constants, but if their chirality is incompatible with the active kernel, coupling may produce stress, repulsion, or decoherence.

real compatibility $\Rightarrow$ compatibility (α, S, χ)

Therefore, taxonomy must retain both signs simultaneously: axial direction and chirality. A flow is not completely defined by being right-handed or left-handed; it is defined by the relationship between the direction of transport and the direction of winding. *Here lies one of the keys to the fermionic and bosonic classification in the Unified Theory. The Fundamental Code, the set of primary interaction rules from the first volume of the theory, was defined by the direction and chirality of helical flows.*

13.7. Chiral regimes: stable, dual, and reconfigurable

The first volume of the book already introduced the idea that natural helical geometries have only two fundamental variants: right-handed chirality and left-handed chirality. This distinction must be preserved, but in the present volume it must be formulated more precisely. It is not enough to say that right and left exist. We must state which classes of flows can exist in a single chirality and which can exist in both.

The first is the stable chiral regime: within the stated experimental domain, the flow preserves the same chirality and does not transition into the mirrored configuration under the tested perturbations. The absolute impossibility of reversal is not postulated; it must be replaced by a measured threshold of chiral stability. Analogically, this regime may be called restrictive, of the fermionic type.

Monochiral regime: $X\chi = \{\chi_0\}$

The second is the dual chiral regime: the same family of equations and conditions admits stable right- and left-handed solutions. The existence of both solutions does not automatically demonstrate aggregation; collective behavior must be verified from C–C dynamics. Analogically, this regime may be called collective, of the bosonic type.

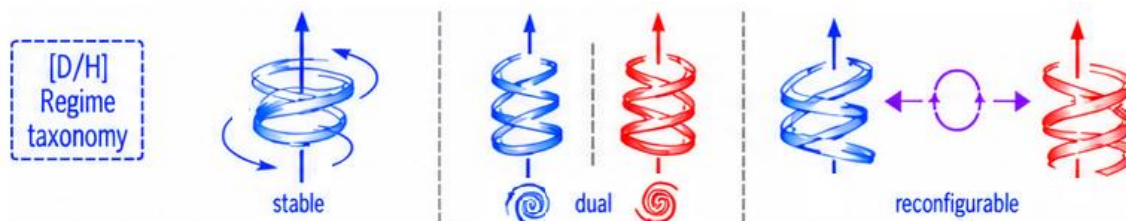
Bichiral regime: $X\chi = \{+1, -1\}$

The third is the reconfigurable chiral regime, called ‘predonic’ only in the internal vocabulary of the theory. It does not denote a new particle, but a state in which an external perturbation can controllably

reverse chirality without destroying the defined identity. The existence of the regime requires demonstration of a reversible transition and its threshold.

Predonic regime: $X\chi = \{\chi \text{ variable through external coupling}\}$

The predonic regime has great conceptual value because it introduces the class of flows upon which the environment can act directionally. This may include direction filters, chirality filters, nodes capable of reversing or reorienting outputs, materials that polarize flows differently, and technical systems that modify the rotational state of the flow. In later chapters, this regime may help describe material polarizations and interactions with detectors.



The three chiral classes are associated with particle classes in current physics, but have a different meaning. The terms fermionic, bosonic, and predonic are used here geometrodynamically. They describe modes of flow behavior: restriction, collectivity, and modifiability. Current physics retains its definitions through spin and quantum statistics. *The Unified Theory proposes a geometric level of interpretation, not a direct replacement of the established formalism.*

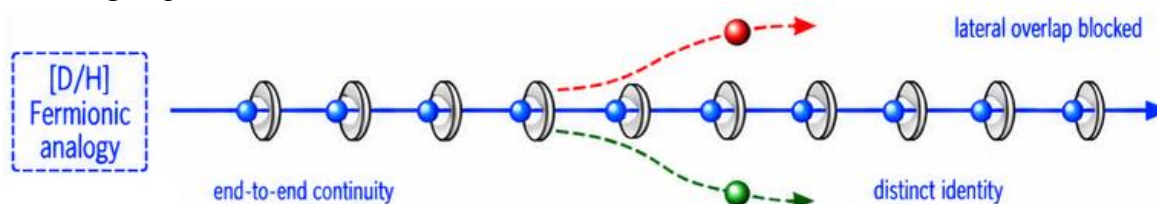
13.8. The restrictive axial regime — fermionic analogy

The restrictive axial regime describes flows that preserve their identity through chiral stability and end-to-end continuity. The designation ‘fermionic’ is only a geometric analogy; the chapter does not derive half-integer spin, the exclusion principle, or Fermi–Dirac statistics.

In such a regime, each flow preserves its individuality. Coupling is strict, and compatibility must be satisfied simultaneously at the level of constants, α , axial direction, and chirality. For this reason, M–C interactions come closest to fermionic behavior: they link flows along the axis, in a continuity in which one state extends another.

fermionic $\Rightarrow$ axial continuity + chiral restriction + distinct identity

This class is important for understanding filaments, long threads, chains, and structures that cannot overlap laterally without losing their identity. *It explains why certain flows do not spontaneously form collective bundles, but prefer directional continuities. In natural terms, the fermionic regime makes the thread as long as possible and strikes at a distance.*



A fermionic thread may be part of a larger ensemble, but it does not dissolve completely into it. It may be constrained by the tree, may pass through nodes, may participate in kinematic correlation through common origin, yet it preserves a stronger identity than a bosonic flow. This persistent identity is an evolutionary advantage in directional transport, but becomes a vulnerability in regimes where lateral flexibility is required.

13.9. The collective lateral regime — bosonic analogy

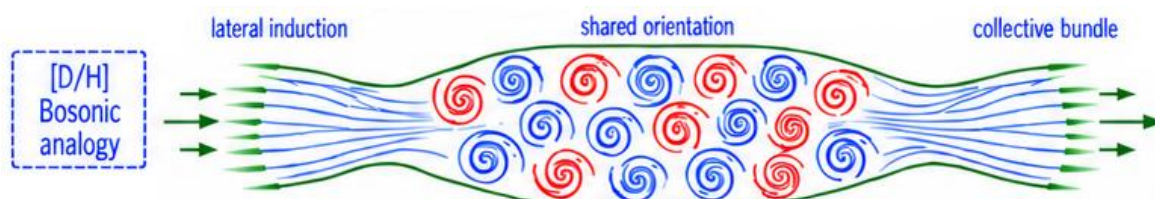
The collective lateral regime describes flows that can form aggregates and bundles through C–C interaction, if the state vector, phase, and contact geometry permit a stable solution. The term ‘bosonic’ is only an analogy and does not imply integer spin or Bose–Einstein statistics.

bosonic $\Rightarrow$ lateral aggregation + bichirality + collective state

The kernel C–C is the most important locus for this behavior. Through lateral induction, a flow may replicate or attract compatible flows into a bundle. This bundle is not a mere agglomeration. It has shared

memory, shared orientation, and can develop branches at IN and OUT. *In simple terms, the bosonic regime makes the bouquet as thick as possible.*

This property is essential for growth. A single flow can transport, but a bundle can build volume, a common field, a layer, a node, or geometrodynamic tissue. In an evolutionary reading, bosonic behavior is close to collective emergence. It permits the appearance of larger structures, conglomerates, polarized nodes, and tree-like architectures.



Nevertheless, bosonic freedom does not mean the absence of criteria. If α is incompatible, aggregation does not occur coherently. If the permitted chirality does not include the required orientation, geometric stress appears. If the internal phases are incompatible, the bundle may become unstable. *Thus bosonic behavior is not mere union, but union filtered by state.*

13.10. The reconfigurable chiral regime ('predonic')

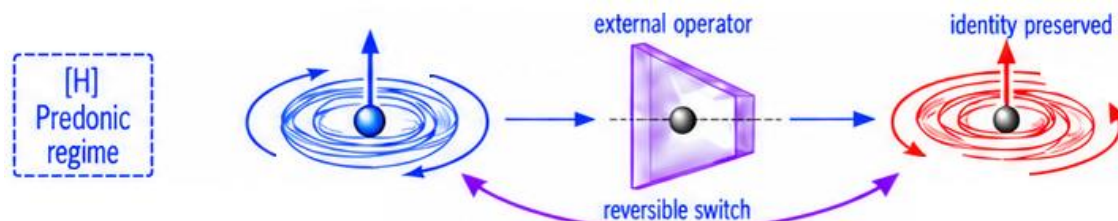
The predonic regime deserves a separate position because it can preserve an older idea of the theory without forcing it into a premature physical claim. In its present form, the predonic regime must be defined as a regime of chirality modifiability. A predonic flow is a flow that can be switched externally from one orientation to another, without this necessarily meaning the complete destruction of the structure.

This regime differs from bichirality. In the bosonic regime, both chiralities may be natural to the class. In the predonic regime, chirality may be imposed, changed, or selected by a system of influence. This difference is important. The predonic regime is not spontaneous freedom, but controlled or conditioned modifiability. Human intervention in changing chirality, through various mechanisms, is specific only to these classes of flows.

The photonic jet may be proposed as a candidate for a reconfigurable chiral regime only if a physical operation produces controlled and reversible chirality inversion, distinct from a mere rotation of polarization.

In nature and technology, such a regime may occur wherever an external system functions as a direction filter, a chirality filter, or a reorientation operator. A material edge, a polarized surface, a slit, a vortex node, a stratified field, a toroidal region, or a detector may produce such effects. The flow does not change its chirality because it is indifferent to orientation, but because the environment compels it to choose or update a compatible orientation.

The regime internally called 'predonic' is the hypothesis in which chirality is not determined only at genesis, but can be reconfigured by the environment. The name does not designate a recognized particle and remains an internal category until its mechanism and observables are defined.



This class will become important in the chapter on conglomerate polarization. Nodes do not merely receive flows; they can reorient them. If reorientation involves axial direction, chirality, or stratification, then the node becomes a predonic operator in the geometrodynamic sense. Materials that modify the polarization of light can also be placed here, not as mere passive surfaces, but as interaction structures capable of selecting or reversing orientations.

13.11. Classes by dominant kernel

In addition to the Preda triplet, α , axial direction, and chirality, the taxonomy must account for the dominant kernel. A flow does not exist in isolation from the interactions that gave rise to it or maintain it. The dominant kernel indicates what type of geometrodynamic relationship formed the structure: genesis, axial continuity, lateral induction, or perpendicular induction.

A C–A flow is a flow in relation to an attractor. It belongs to the regime of genesis, capture, initiation, and potential difference. It is a starting flow, forming the axis and the initial orientation. It may be extremely stable, unstable, or may rapidly transition into other forms.

An M–C flow is a flow of axial continuity. It is important for chains, filaments, long paths, and analogous fermionic behavior. Here identity is conserved through axial succession.

A C–C flow is a flow of lateral induction. It is important for replication, bundles, bouquets, volumetric growth, and bosonic behavior. Here identity is conserved and multiplied through lateral compatibility.

A T–C flow is a flow of perpendicular induction. *It is important for rings, layers, nodes, transverse fields, and reciprocal conversions between cylinder and torus.* Here identity is tested through a change of plane.

$$\mathbf{K} \in \{\mathbf{C-A}, \mathbf{M-C}, \mathbf{C-C}, \mathbf{T-C}\}$$

Nevertheless, a mature flow may have a composite history. It may arise through C–A, stabilize through M–C, replicate through C–C, and develop layers through T–C. *Therefore, the taxonomy must record not only the instantaneous kernel, but also the history of kernels. This history becomes evolutionary memory.*

$$\mathbf{K}_{\text{hist}} = (\mathbf{K}_1 \rightarrow \mathbf{K}_2 \rightarrow \mathbf{K}_3 \rightarrow \dots)$$

In the complete taxonomy, two flows may have the same constants but different formation histories. This difference may explain why they respond differently to the same environment. A flow born directly from a genesis regime Σ_{gd} is not historically identical to a flow laterally replicated from a mature bundle, even if for a short interval they exhibit similar state values.

13.12. Primary, induced, replicated, and stratified flows

Combining the state criteria with the kernels yields several important functional classes. *Birth becomes the primary flow.* This is the flow that appears through systemic separation and genesis. It is associated with the first IN–path–OUT delimitation, the appearance of an axis, and the initiation of an identity. In the chapter on the Σ_{gd} regime, this class will be linked to the first F.T.W. and the genesis threshold.

The second is the induced flow. It does not arise on its own, but as a result of the action of another flow or a node. Induction may be axial, lateral, or perpendicular. An induced flow bears the signature of the driving flow in its structure, but is not automatically identical to it. It may preserve compatibility, deviate, transform the plane of organization, or begin a new family.

The third is the induced flow with state fidelity, a candidate for the designation replica. It would arise through C–C and must preserve the independent vector and the chiral class within measured tolerances. In the internal taxonomy, the mirror replica is analogically associated with the collective regime previously called ‘bosonic,’ without identification with Bose–Einstein statistics. Geometrodynamics hereditarily is admitted only if the induced structure can transmit the same state onward.

The fourth is the stratified flow. It appears when several compatible flows organize into shells, mantles, layers, and edge zones through spherical or toroidal envelopes. This class directly prepares the chapter on polarization. Layers are not mere material thicknesses, but regions for the selection and reorientation of flows. In the future analysis of materials, edges, and fringes, this class will become essential.

These four functional classes are not absolutely exclusive. A flow may be primary at birth, induced at one stage, replicated within a bundle, and placed on a layer. The taxonomy must not freeze the flow into a single name, but must be able to describe its evolutionary path.

13.13. Geometrodynamic species and subspecies

The terms class, species, and subspecies must be used carefully. They do not copy biology, but provide a language for different levels of identity. A geometrodynamic class is a broad domain of compatible states. A geometrodynamic species is a narrower family capable of coherent coupling, replication, or continuity without changing identity. A subspecies is a local adaptation of a species to an environment.

Consequently, a flow species is not defined by looking the same, but by being able to transmit the same state memory. Two flows belong to the same species if they can replicate or continue one another without changing the fundamental set of constants. If replication produces another set of constants, we no longer have the same species, but the emergence of a new geometrodynamic species.

species $\Rightarrow$ coherent replication of state $\mathcal{S}\chi$

species mutation $\Rightarrow \mathcal{S}\chi \rightarrow \mathcal{S}\chi'$ through decoherence and reconfiguration

Subspecies appear when the same species adapts to different environments. A flow may preserve the triplet and α while having a different radius, local pitch, lateral amplitude, stratification, or interaction history. These variations are insufficient to change the species, but sufficient to recognize subspecies.

This structure makes an evolutionary taxonomy possible. Flows are not placed in a dead catalog, but in a tree of transformations. A class may give rise to several species. A species may produce subspecies. Through accumulated stress and reconfiguration, a subspecies may become a new species. This is where geometrodynamic Darwinism and taxonomy unite.

For clarity, the main criteria can be arranged in a minimal table. This is not yet a complete periodic table of helical flows, but an initial scheme capable of preserving the essential ideas without confusing them.

Taxonomic level	Criterion	Fundamental question	Effect in the theory
Primary identity	C_c, C_r (C_f and C_e reported separately)	What internal memory does the flow conserve?	Defines the geometrodynamic core.
Coupling	α (hypothetical diagnostic)	Which candidates pass the preliminary scalar filter?	Proposes a compatibility family that must be tested.
Orientation	S	What is the direction of IN–path–OUT?	Defines the functional direction.
Chirality	χ	How does the flow twist relative to the axis?	Filters coupling and polarization.
Chiral class	$X\chi$	Which chiralities are permitted?	Separates fermionic, bosonic, and predonic regimes.
Dominant kernel	K	What interaction forms or maintains it?	Defines genesis, continuity, replication, or perpendicular induction.
Evolutionary history	K_{hist} , decoherences	What transformations has it undergone?	Defines species, subspecies, and state mutation.
Function	IN–path–OUT	What transport does it perform?	Links taxonomy to the open system.

13.14. Minimal taxonomic table

The table shows that taxonomy cannot be reduced to a single parameter. A flow is classified neither by α alone, nor by chirality alone, nor by kernel alone. Complete identity appears through the superposition of all criteria. This is one of the important differences from simple classifications based on form or observable effect.

In the future, the scheme may be expanded into an empirical atlas of helical flows. The axes must be chosen from independent and observable components, while α may be reported only as a derived diagnostic. Groupings become scientific classes if they predict stability, transitions, or interactions on data not used for classification.

13.15. Taxonomy and node polarization

The next chapter will use this taxonomy directly. A node of vortices, a skein, does not receive abstract flows. It receives flows with a class, species, α , axial direction, chirality, dominant kernel, and history. Therefore, the node cannot distribute the outputs arbitrarily. It must select, reject, absorb, reorient, or emit flows according to their taxonomic state.

This is where conglomerate polarization (POL) will be introduced. A conglomerate has multiple vortex-tube inputs and outputs. Depending on the classes of flows received, it may organize into POL-1, POL-2, POL-A, or POL-B. Some polarizations remain bipolar, others become multipolar, while others develop poles and layers. Without taxonomy, these polarizations would appear to be mere forms. With taxonomy, they become selective responses

of the node to the flows it receives.

Taxonomy also prepares the notion of filters. A direction filter is a region that accepts or rejects flows according to S . A chirality filter accepts or rejects flows according to χ or $X\chi$. An α filter accepts or rejects flows according to the compatibility parameter. A real node may combine all these filters. This gives rise to preferred inputs, preferred outputs, field layers, and collective orientations.

Taxonomy says what the flow is; polarization says what the node does with it.

This distinction ensures the transition to node polarization. This chapter classified flows. The next chapter will show how these flows, once they reach a node or conglomerate, organize into polarizations. The four forms POL-1, POL-2, POL-A, and POL-B will be revisited there, together with fermionic and bosonic chirality, the predonic regime, and the idea of flow layers associated with materials, edges, and marginal fields.

13.16. Conclusion — flow as a state species

The proposed taxonomy moves from the general description of the vortex to a provisional classification of flow states. Classes, species, and chiral regimes are organizational hypotheses that must be extracted from data; the fermionic, bosonic, and ‘predonic’ analogies are not classes of quantum particles.

A flow is hypothetically recognized by what it preserves. The independent vector defines kinematic memory, while the Preda triplet provides operational measurement pathways. Axial direction, chirality, and phase describe orientation; the dominant kernel and kernel history describe interaction. α remains a derived scalar filter, not a demonstrated compatibility criterion.

From this perspective, taxonomy is not a mere static classification. It is the instrument through which geometrodynamical Darwinism becomes intelligible. Only what can be identified can be tracked. Only what can be tracked can be compared. Only what can be compared can be understood as evolution.

helical flow = state species, not a rigid object

The next chapter will show what happens when these state species are no longer analyzed in isolation, but enter a node, a conglomerate, or a material region. There taxonomy becomes polarization, and classified flows become inputs, outputs, layers, filters, and collective orientations.

14. Conglomerate polarization — the unified polarization scheme

14.1. Why polarization must be rewritten

The preceding chapter arranged helical flows into state classes. Taxonomy tells us what kind of flow we have: what constants it conserves, what α value it carries, what axial direction it has, what chirality it manifests, and what analogous behavior—fermionic, bosonic, or predonic—it can develop. But an isolated flow is only a methodological limit. In reality, flows gather into clusters, skeins, conglomerates, and nodes. They form agglomerated systems, often almost spherical, around which marginal flows, inputs, outputs, layers, and poles are organized.

At this point, polarization appears. In the Unified Theory, polarization is not the polarization of waves in classical optics and must not be reduced to the orientation of an electromagnetic oscillation.

Polarization is the global distribution of helical flows entering and leaving a cluster. It mirrors the intuitive notion of magnetic poles: a system is polarized not because a wave oscillates in one direction, but because its external ensemble of flows is organized into poles, multipoles, and layers.

Under the proposed hypothesis, conglomerates would interact through marginal state distributions. The magnetic and gravitational examples are correspondence analogies: they neither demonstrate the existence of magnetonic or gravitonic flows nor authorize automatic extension to photons, gluons, or the weak and strong interactions.

Current physics — *The Standard Model of particle physics is defined by $SU(3) \times SU(2) \times U(1)$ gauge symmetry, quantum fields, charges, spin, statistics, and coupling constants; gravity is described separately by general relativity.*

The theory's proposal — *POL-1, POL-2, POL-A, and POL-B form a hypothetical geometric classification of IN–OUT distributions around a cluster. The magnetonic, gravitonic, weak, or strong associations are candidate correspondences, not identifications.*

The missing bridge — *The scheme must derive the symmetries, degrees of freedom, charges, spin, statistics, ranges, and strengths of the interactions, or show precisely how they emerge from the vortex variables.*

[F] Test criterion — *Each POL class must generate a calculable field and a distinct prediction for dependence on distance, orientation, energy, or material; a verbal association with a known force (gravity, magnetism) is insufficient.*

Polarization is grounded in chirality, but manifests as field architecture. Chirality establishes the internal compatibility of flows. Polarization establishes their global distribution around the cluster. The four types of polarization are neither four kernels nor four forms of helical-whip polarization, but the four fundamental ways in which a cluster model can organize its marginal flows.

polarization = global IN–OUT distribution of a flow class around a cluster

14.2. The cluster, the helical skein, and marginal flows

In its fundamental form, the cluster is a skein of helical flows: a stabilized accumulation of internal flows and subflows, with at least one input region and one output region. It is not an inert ball, but an equilibrium geometry in which vortices, subtubes, and vortex lines are retained in a compact form. In ideal geometry, the sphere or skein represents the stability limit of packing, while the helical flows within give it a processual character.

But every stable cluster also has an exterior. *Marginal flows appear around it: paths that leave the cluster, return to it, surround it, pass through it, or connect it to other clusters. These marginal flows are not decoration. They are precisely what allows the system to interact at a distance. When two clusters are spatially separated, the first things to meet are not their cores, but their networks of external flows.*

From this perspective, a ‘particle’ is not a point. It is a conglomerate with a core and marginal fields. The core preserves internal coherence; the marginal fields produce connections. If such a conglomerate carries four dominant flow classes, then it has four types of surrounding fields. Each class may have its own polarization. It is precisely the composition of these polarizations that forms the particle's interactive identity.

The unified polarization scheme is defined as a hypothetical cluster surrounded by marginal distributions, provisionally classified as POL-1, POL-2, POL-A, and POL-B. It is not the Standard Model of particles and does not yet provide demonstrated support for known fields.

unified polarization scheme = hypothetical cluster + candidate POL marginal distributions

14.3. Chirality as the foundation of polarization

Polarization cannot be understood without chirality. A helical flow has an axial direction and a direction of twist. Only together do these permit chirality to be established. When several flows organize around a cluster, their chiralities are not local details, but criteria of global compatibility. Two flows may have the same α value and still fail to couple stably if their directions and chiralities do not match.

Fermionic behavior, in this theory, is linked to chiral restriction and the strict organization of flow. It tends toward polarizations in which direction and chirality impose precise directions of continuity. Bosonic behavior is linked to the capacity for aggregation, superposition, and collectivization of flows.

It permits bundles, bouquets, common fields, and more freely distributed states. The predonic regime appears when an external system or a node can modify the direction or chirality of a flow, transforming it from a given state into a state shaped by the environment.

For this reason, the four polarizations include all fermionic, bosonic, and predonic classes. POL-1, POL-2, POL-A, and POL-B do not belong exclusively to a single class. They are four modes of distribution, and the flow classes may occupy these modes according to the cluster's internal composition and the external environment.

chirality establishes compatibility; polarization establishes global distribution

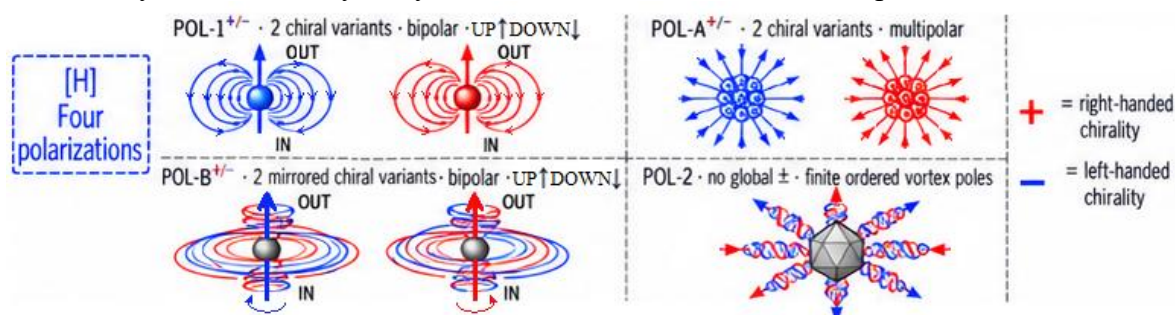
14.4. The unified scheme — the four proposed types of polarization

The four types are denoted POL-1, POL-2, POL-A, and POL-B. The notation derives from the Fundamental Code in the theory's first volume and is correlated here with the C–A, M–C, C–C, and T–C kernels. The Fundamental Code establishes the possible directions and chiralities of flows; polarization establishes how these possibilities are globally distributed around a cluster.

The four proposed polarizations are arranged by two criteria: bipolar/multipolar distribution and a parallel/antiparallel relationship with specified chirality. This is a schematic partition; its completeness has not been demonstrated and must be tested against oblique, noncoplanar, torus–torus, and multi-structure configurations.

Type	Distribution	Kinematic relationship	Meaning in the present theory
POL-1	bipolar	parallel-chiral	radial-type dipolar model; magnetonic polarized-class type; dominant IN–OUT (up/down) poles / attractor–repeller; defined cluster chirality (+/–)
POL-B	stratified bipolar	parallel-antichiral	enveloped vortex-type dipolar model, dominant IN–OUT (up/down) poles / attractor–repeller; ring-shaped marginal flows; field and chirality layers; defined cluster chirality (+/–)
POL-A	multipolar	antiparallel-chiral	radial-type multipolar model; gravitonic multipolarized-class type; permanent global-type attraction; defined cluster chirality (+/–)
POL-2	multipolar	antiparallel-antichiral	vortex-type multipolar model; complex distribution of poles and peripheral flows; supergravitonic multipolar class [H]; undefined cluster chirality

The table classifies the ways in which a flow class arranges itself around a cluster. A magnetonic flow may be POL-1, a gravitonic flow may be POL-A, while another flow class may manifest POL-B or POL-2. What matters is that polarization belongs to the flow class, not to the cluster as a whole. The same cluster may simultaneously carry several classes, each with its own polarization.



Therefore, a cluster does not have one simple total polarization. It has a composite signature. In an exploratory notation, an electrically charged particle exhibiting electromagnetism, gravity, weak flow, and strong flow could be schematically denoted by a composition such as POL-1A2B. This notation is not a final particle code, but a methodological indication: each class of the cluster's marginal flow can receive one of the four polarizations.

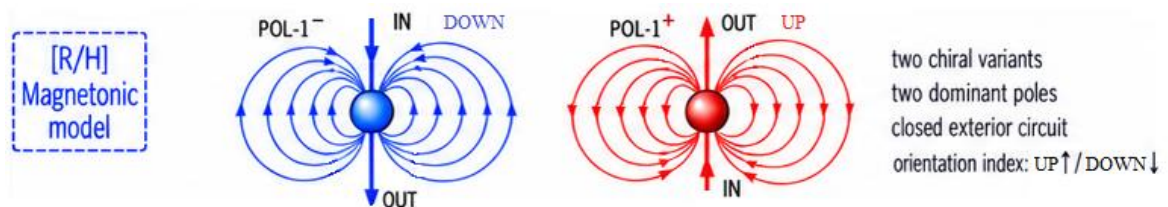
14.5. POL-1 — bipolar polarization specific to the magnetonic class

POL-1 is the most intuitive bipolar polarization. It corresponds to a cluster around which a certain class of flows is organized into two principal poles. In the macroscopic analogy, the magnetic field of a magnet or planet provides the simplest image: there is a dominant axis, an input pole, an output pole, and a network of flow lines that closes the external circuit.

In the language of the theory, POL-1 may be associated with the class of magnetonic polarized flows. The term ‘magnetonic’ must not be read as an already established standard particle, but as the name of a class for flows that produce magnetic-type effects through bipolar distribution. In this interpretation, a magnet is a cluster or an ensemble of clusters whose magnetonic flows have sufficiently coherent polarization to produce detectable attractions, repulsions, and orientations.

Two POL-1 clusters do not touch directly through their cores. Their marginal magnetonic flows intersect first. When the orientations are compatible, attractive connections appear. When the orientations are incompatible, repulsions or reorientations appear. This explains why the notion of polarization is fundamental: the pole is not merely a point on the surface, but the region where a class of marginal flows concentrates its input or output.

To distinguish between left- and right-handed constituent chiralities, I have associated a specific external chiral behavior of the + or – type. This index marks both internal composition and external behavior. In interaction, a visual description of direction is also required, with the OUT output pole positioned either up or down.



POL-1: two dominant poles, coherent marginal flows, magnetonic-type interaction

14.6. POL-A — multipolarization specific to the gravitonic class

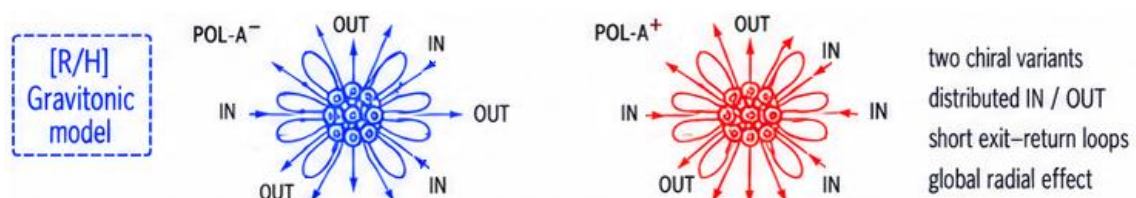
POL-A is the multipolar polarization associated, in the initial intuitive interpretation, with gravity. If POL-1 is easy to understand through the magnetic-dipole model, POL-A must be understood through the far more global distribution of flows connecting every cluster to every other cluster. Here we no longer have only two obvious poles, but a vast number of inputs and outputs distributed over the entire surface of the skein.

The class of gravitonic-type multipolarized flows does not need a single visible axis to produce an effect. It works through a network of peripheral connections that is apparently omnidirectional but not disordered. Each flow thread has direction, chirality, and compatibility, yet the ensemble is perceived as global radial attraction. For this reason, gravity appears in current physics as a universal attraction, without the simple attraction–repulsion alternation specific to magnets.

The association of POL-A with gravity is a correspondence hypothesis. To explain gravitational attraction, the model must derive a universally attractive interaction, inertial-mass–gravitational-mass equivalence, distance dependence, and the relativistic limit; declarative multipolarization is insufficient.

The example of the two magnets therefore becomes essential. Two magnets always attract gravitationally through the gravitonic POL-A class, but they may attract or repel magnetically through the magnetonic POL-1 class. In an ordinary experiment, the magnetic effect is much stronger and becomes dominant, but it does not cancel the gravitational interaction. Each class preserves its own polarization and its own mode of coupling.

A similar index marks both internal composition and external behavior.



POL-A: distributed multipoles, global radial attraction, marginal gravitonic flow

14.7. POL-B — stratified polarization and enveloping fields

POL-B is the most interesting form. It is the bipolar polarization that develops an envelope of flows around the IN–OUT axis and may be described as the surrounded or ‘dressed’ variant of a tornado. The formulation designates not only two visible tornadoes (at IN and OUT), but also a family of marginal flows that flatten into pseudocircular sections, forming layers, mantles, or concentric rings around the cluster.

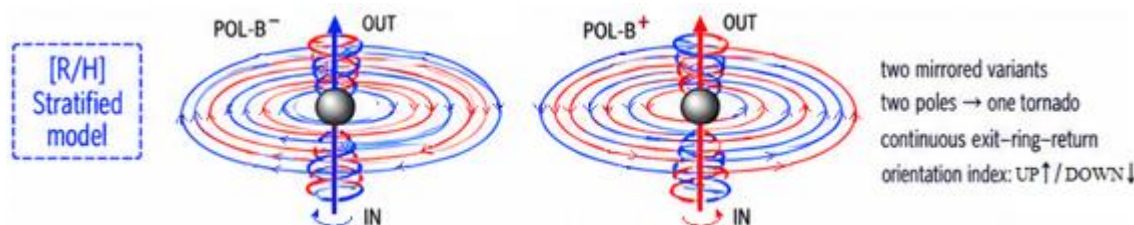
Through POL-B, the periphery becomes active. If POL-1 organizes two poles and POL-A distributes multipoles, POL-B builds a layered interaction zone. Each layer may have a different radius, flow density, chirality compatibility, and capture capacity. Small tracers situated in these peripheral flows may describe strict, specific orbital motions. Their position is not arbitrary, but may be correlated with the position of the subtornadoes, the layer density, and the winding geometry.

POL-B may be explored as a marginal-stratification hypothesis, but planetary rings, surface fields, and fringes (layers) have distinct standard explanations. A fringe does not constitute evidence of an invisible layer; the model must predict a material- or distance-dependent deviation that remains after the complete electromagnetic calculation.

The proposed candidate is the quantum atom, whose orbitals define regions of high electron probability. Electron shells are arranged hierarchically as shells, subshells, and orbitals. Through bipolar tornadoes, atoms select compatible species.

POL-B is therefore the polarization that transforms a simple boundary into a region of stratified selection. A surface is not merely a plane of contact, and an edge is not merely a geometric line. They may become local manifestations of a stratified polarization, where flows are accepted, rejected, absorbed, or reoriented according to their distance from the core and compatibility with the layers.

The + or – index identically marks internal composition and external behavior. The OUT direction of the vortex outside the cluster, required in the interaction, may also be indicated by the up/down indices.



POL-B: bipolar axis + flow envelopes + layers of compatibility at a distance

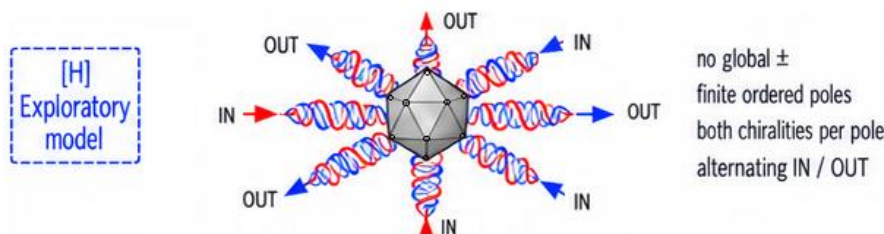
14.8. POL-2 — complementary vortex-type multipolarization

POL-2 is the multipolar form complementary to POL-A. If POL-A can be intuited through the global attraction of gravitonic flows, POL-2 describes a multipolar distribution in which directions and chiralities produce a different organization, one more difficult to reduce to a single classical image. It may occur in clusters with complex peripheral interactions, in which multiple vortex-type inputs and outputs do not combine into a simple global effect, but into networks of coupling, decoupling, and reorientation.

POL-2 prevents the unified polarization scheme from being reduced to only two intuitive examples, magnetism and gravity. It provisionally groups marginal distributions that behave neither as a simple dipole, nor as global multipolarization, nor as a POL-B layer; class membership must be decided through observables and predictions. The number of vortex-type poles is not reduced to two, but to a finite number.

In a mature theory, POL-2 may become important for describing flows associated with less intuitive interactions, unstable states, transitions between classes, or predonic regimes in which chirality may be modified by the environment. Therefore, POL-2 must be retained as a fundamental polarization, even if its experimental image is not as immediate as that of a magnet or a gravitational mass.

[H] Exploratory cosmological and technological hypothesis, without observational confirmation.



The model would permit the detection of planetary regions in which possible galactic vortices produced local signals. Although there is currently no evidence that supergravity tornadoes could be IN/OUT corridors connected to the center of the galaxy, the possibility may be considered. One might even consider that such a support would locally perturb gravity or cancel electromagnetic effects. If these channels existed, one could ask speculatively whether an advanced civilization might use them as 'transport highways' and whether the flows would disturb electronic equipment or alter the state of accumulators and batteries. The internal term 'supergravity' does not designate the supergravity of supersymmetric theories and must not be treated as a physical quantity before a field, a source, a propagation law, coupling, and a reproducible signal excluding standard geophysical, meteorological, and electromagnetic explanations have been defined.

[F] The minimum criterion for this extension is predictive: the channel geometry, spatial and temporal dependence, transported energy and momentum, interaction with matter, and a signal unexplained by standard gravity, meteorology, geophysics, or magnetohydrodynamics must be specified. In their absence, the 'highways' remain an explicitly marked imaginative hypothesis, not a conclusion of the theory.

14.9. Long-distance interaction between clusters

A cluster interacts with another cluster through its marginal flows. This is the central idea that must be retained. In the primary sense, it is not two bodies that touch directly, but two flow architectures that enter into compatibility or incompatibility. What is called force is the global effect of these marginal compatibilities.

The Unified Theory proposes seeking vortex representations for fields, but it cannot identify a POL class with an interaction through geometric resemblance alone. Each correspondence must provide the field equation, source, symmetry, propagator or classical limit, and the associated conservation law.

This explains why the same pair of objects can simultaneously have several types of interaction. Two magnets have mass and attract gravitationally. The same two magnets have magnetonic polarization and may attract or repel magnetically, depending on the orientation of the poles. If they are electrically charged, another class of flows also enters. There is no single absolute interaction, but several superposed flow channels, each with its own polarization and intensity.

In this sense, the unified polarization scheme is a theory of the marginal-flow fields of clusters. The field is neither a separate substance nor a mere mathematical value assigned to space. The field is the way in which a flow class of a cluster is distributed externally and becomes capable of forming connections with other clusters.

14.10. The unified scheme as a superposition of polarizations

In the unified polarization scheme, a particle must be treated as a conglomerate of flows with a core and periphery. The core is the coherent skein that maintains internal identity. The periphery is the ensemble of flows through which the particle interacts. Each peripheral flow class can be denoted by a polarization of type POL-1, POL-2, POL-A, or POL-B. The particle's interactive identity is the composition of these polarizations.

This composition must not be confused with a final calculation formula, but understood as a conceptual architecture. For example, a cluster may have a POL-A gravitonic class, a POL-1 magnetonic class, a POL-B stratified class, and a complementary POL-2 multipolar class. Depending on which class dominates an experiment, the observer will say that gravity, magnetism, absorption, reflection, chemical bonding, weak interaction, strong interaction, or another effect is being seen.

Current physics measures effects and constructs specialized theories for each effect. The Unified Theory proposes that beneath these effects there is the same geometrodynamic model: the cluster bearing polarized marginal flows. Consequently, the 'particle' is not a point with attached properties, but a skein of flows that carries its properties in its peripheral distributions.

Structural hypothesis: **particle-cluster = vortex core + marginal POL distributions**; the number and completeness of the classes remain to be demonstrated.

14.11. Polarization, bonds, and self-assembly

When two conglomerates described by the unified polarization scheme approach, their marginal distributions test one another. Some inputs may find compatible outputs, while others may be repelled, aligned axially, or composed peripherally. The ionic, covalent, and metallic analogies remain structural comparisons, not chemical identifications.

The self-assembly of matter begins through these polarization compatibilities. A cluster does not bind to every other cluster. It binds to those clusters whose marginal flows permit continuity, closure, compensation, or stratification. Polarization thus becomes the mechanism through which flow taxonomy passes into material architecture. The class says what flows; polarization says how it can bind.

This idea preserves unity with geometrodynamic Darwinism. Not every bond survives, but only the bond that can conserve the coherence of both systems involved or produce a new shared coherence. When polarizations are incompatible, the systems repel, disorganize, or enter reconfiguration. When they are compatible, a larger structure appears: molecule, crystal, tissue, bundle, node, tree, or cosmic system.

14.12. Pole migration and environmental influence

Polarization is not always fixed. Depending on the cluster's internal structure and the external environment, poles may move, multipoles may redistribute, and a polarization may pass through phases of instability. The example of the geomagnetic poles suggests extending this idea beyond the particular case. Any sufficiently fluid, energetic, and environmentally sensitive cluster may undergo migration of the poles of its marginal flows.

The greater the internal energy and the more fluid the structure, the more readily the external flows are rearranged. A young planet, a star, a plasma, an excited material, an unstable cluster, or a particle in an intense environment may change the distribution of inputs and outputs. This does not mean that the system immediately loses its identity, but that it adapts its marginal fields to its environment.

In extreme regimes, pole migration may pass through a multipolar phase. A bipolar system may temporarily fragment into several poles and then reorganize into a new polarization. This is a form of geometrodynamic adaptation of the external field. At the planetary scale, its traces may be read in magnetic structures, rings, auroras, or polar dynamics. At the microscopic scale, the same principle might appear as a change of state, spin reorientation, coupling modification, or phase transition.

14.13. POL-B layers and materials with envelopes

The idea of layers must be preserved and extended carefully. In addition to thicker or thinner inputs and outputs, clusters also have multiple envelopes of marginal flows. If POL-B represents a polarization enveloped by flows, then materials may have stratified marginal fields at their surfaces and edges. A material does not end merely at a geometric boundary. It may carry around its edge a succession of compatibility layers generated by atomic structure, electron density, polarizability, local stresses, and the chirality of marginal flows.

These layers are only bosonic in nature, through geometrodynamic polarization. Some may be interpreted as surface-field distributions with effects not yet understood, while others may remain undescribed by the language of current physics. In the present theory, they are important because they may reorient photonic jets, select flows, and explain why the same slit or edge geometry behaves differently in different materials.

When a photonic jet passes near an edge, it does not encounter a mathematical line, but a stratified periphery of the material. If the jet has an internal species—helical pitch, frequency, chirality, phase,

lateral orientation—then it may react selectively with one or another of these layers. This may give rise to deflection jumps, fringes, polarization differences, partial absorption, partial reflection, and lateral reorientation.

Testable hypothesis: a residual fringe component could indicate marginal stratification only after subtracting the standard electromagnetic prediction.

14.14. What conglomerate polarization is not

To avoid confusion, it must be specified what the polarization discussed here is not. It is not optical polarization defined by the orientation of the electric-field vector. That polarization may later be treated as a particular effect at the level of photonic jets. Conglomerate polarization is more general and deeper: it defines the distribution of a class's marginal flows around a cluster.

Nor is it a kernel. Kernels describe elementary interactions between flows: genesis, axial continuity, lateral replication, or torus–cylinder induction. Polarization describes the global state of the cluster after the flows are organized around it. Kernels are local mechanisms of interaction. Polarization is global field architecture.

Nor is it given by chirality alone. Chirality is the twisting orientation of the flow relative to the axial direction. Polarization is the way in which many chiral flows are distributed around a core. Without chirality, polarization cannot be built, but polarization is not reducible to chirality.

14.15. The hypothesis of vortex-conglomerate polarization

[H] The central hypothesis of the chapter states that a vortex cluster can interact through marginal distributions provisionally classifiable as POL-1, POL-2, POL-A, or POL-B. It has not been demonstrated that every cluster possesses these distributions or that the four classes exhaust the space of configurations.

[H] This formulation expresses the proposed ontology, not an established result: particles are modeled as conglomerates, fields as marginal flows, and forces as effects of coupling between polarizations. A physical correspondence requires equations that recover known masses, charges, spin, statistics, and interactions. Until then, chirality, layers, and peripheral memory are components of the conceptual model.

The unified polarization scheme is not a list of particles, but a provisional geometric classification. POL-1, POL-2, POL-A, and POL-B are four candidate classes; their completeness and connection to material interactions must be demonstrated.

The distribution of a cluster's IN/OUT gates must not be considered random. A stable cluster in geometrodynamics orders its inputs and outputs according to chirality, axial direction, flow class, and internal compatibility. Consequently, marginal flows form recurring external patterns. These patterns seek equilibrium configurations with simple and stable symmetries, among which the tetrahedral distribution represents a minimal geometric candidate. Thus, cluster polarization is not only a global orientation of the field, but also a geometry for distributing its exchange gates with the exterior.

[H] Hypothesis of the polarization of vortex conglomerates

A stable conglomerate of helical flows organizes each marginal-flow class into one of the four fundamental polarizations POL-1, POL-2, POL-A, or POL-B. Polarization expresses the global IN–OUT distribution of that class around the cluster and determines how the cluster forms long-distance connections with other clusters.

14.16. Polarization as interface identity — hypotheses, consequences, and research program

The preceding subsections introduced POL-1, POL-B, POL-A, and POL-2 as candidate modes for distributing a class's marginal flows around a conglomerate. One clarification in the present scheme is essential to what follows: polarization belongs to the flow class, not to the cluster taken as a whole. The same cluster may simultaneously carry several marginal classes, each with its own polarization and mode of coupling. Consequently, what is observed externally is not a single ‘polarization of the particle,’ but a composite signature of its active interfaces.

This observation permits the transition from taxonomy to a deeper problem. If POL describes how a flow class presents itself at the boundary, then polarization may be treated as interface identity: a geometry through which the system becomes accessible to other systems. It says not only how the flow is organized, but also which channels can be selected, which orientations can be compatible, what response can be induced, and what part of the internal identity becomes visible in interaction.

[H] The central hypothesis of this subsection is that some observed properties of a constituent may belong not to its core as primitive labels, but to the way its internal identity is projected through a POL interface. This hypothesis does not replace the established properties of particles; it requires the geometrodynamical model to reconstruct them and produce additional predictions.

14.16.1. Internal identity and relational identity

A cluster may conserve a stable internal geometry without that geometry alone determining its behavior toward every partner. It is useful to distinguish between internal identity and relational identity. The former brings together the system's constitutive geometry, coherence, memory, kinematic state, and conserved descriptors. The latter appears only in relation to a partner and contains the accessible POL class or classes, exposed chirality, relative orientation, and the IN/OUT channels that can effectively enter into continuity.

$$\begin{aligned} \mathbf{I}_{\text{int}}(\mathbf{C}) &= \{\text{constitutive geometry, memory, } \mathcal{S}_{\text{ind}}, \text{ topology, ...}\} \\ \mathbf{I}_{\text{rel}}(\mathbf{A}|\mathbf{B}) &= \{\mathcal{P}_A, \mathcal{P}_B, \chi_A, \chi_B, \Omega_{AB}, \text{ active IN/OUT channels, ...}\}, \\ &\text{with } \mathcal{P}_X \in \{\text{POL-1, POL-2, POL-A, POL-B}\} \end{aligned}$$

The distinction is not semantic. It allows the same cluster to remain internally identical yet respond differently when the orientation, partner, environment, or dominant marginal class changes. *In this reading, interaction is determined not only by 'what' each system is, but also by 'how' it is presented to the other system.*

[H] POL thus becomes a candidate for a relational layer of physical identity. An observed property may be intrinsic, may belong to the interface, or may result only from the combination of the two. The model must distinguish these cases, not merely rename them.

Critical question. *If two clusters have the same internal architecture but conjugate chiral interfaces, do we have two fundamentally different objects or two relational states of the same construction?*

14.16.2. The chiral index of polarization and the external order descriptor

Chirality and polarization must be kept as distinct concepts. Polarization describes the global distribution of a flow class; chirality describes the helical orientation of the flows. Where the ensemble admits a coherent global chirality, the POL notation may receive a chiral index without creating a new polarization class.

$$\text{POL-i}(\chi), \chi \in \{+1, -1\}$$

The + and – signs here designate only the two conjugate chiral orientations of the same architecture. They are not introduced as electric charge and do not constitute a third taxonomy. For any correspondence with the sign of an interaction, the theory must show through equations that reversing χ reverses an observable and respects the relevant conservation laws.

This notation nevertheless requires two levels of chiral description. A compound vortex flow may internally contain components of both chiralities and, simultaneously, expose a dominant functional chirality at the boundary. To avoid ambiguity with the term 'bichirality' already defined in Chapter 13 as the property of a class capable of stable existence in both chiralities, we will call the simultaneous presence of χ^+ and χ^- components in the constitutive bundle of a POL its internal chiral *composition*. χ_{int} describes this composition, while χ_{ext} describes the effective orientation with which the pole participates in external interaction.

$$\chi_{\text{int}}(\text{pole}) = \{\chi^+, \chi^-\} \mid \chi_{\text{ext}}(\text{pole}) \in \{+1, -1\}$$

Functional axial direction S and chirality χ are distinct descriptors, but they must not be declared mathematically independent in an absolute sense: under the volume's convention, chirality is defined as the direction of twisting relative to the chosen axial direction. Therefore, χ alone does not say whether a

channel is IN or OUT, while the IN/OUT role alone does not determine chirality. The same external chirality may functionally appear on both an IN channel and an OUT channel, provided the same axial convention is preserved.

$S \neq \chi$; $\chi = \chi$ (helical orientation | axial reference S)

[D] To separate local chirality from what may be attributed to the entire interface, we introduce a working descriptor of external chiral order for a flow class j :

$$\Xi\chi(j) = [\sum_k w_k(j) \chi_{\text{ext}, k}(j)] / [\sum_k w_k(j)], -1 \leq \Xi\chi(j) \leq +1$$

The weights $w_k(j)$ represent the relative contribution of the poles or marginal channels relevant to the observable being analyzed, while $\chi_{\text{ext}, k}(j)$ is the functional chirality that pole k exposes to the exterior in class j . The descriptor $\Xi\chi(j)$ is defined only if these local chiralities can be coherently referred to a common oriented reference of the interface. If no such global reference exists, $\Xi\chi(j)$ is not evaluated numerically and is written $\Xi\chi(j)=\emptyset$. When the reference exists, the formula is a discrete working descriptor, not a final field equation, and it permits chiral coherence, compensation, and global indefinability to be distinguished.

$\Xi\chi(j) \approx 0$: external compensation | $\Xi\chi(j) = \emptyset$: global sign undefined

This difference is essential. Zero means a well-defined quantity that cancels; undefined means that the structure does not provide the global reference needed to assign a sign. Experimentally, both may appear as ‘neutrality’ at insufficient resolution, but the mechanisms are different and must be separated through directional measurements.

Moreover, neutrality must be defined for each flow class. Because the same cluster may simultaneously carry several polarizations, a system may be chirally neutral for one channel and polarized for another.

$\Xi\chi(j) \approx 0$ does not imply $\Xi\chi(m) \approx 0$ for $m \neq j$

The ‘geometric sign’ hypothesis can be formulated only in this channel-localized form: a signed observable could depend on POL, on $\Xi\chi$ of the active class, and on the coupling state, not on a global chiral label assigned to the entire cluster.

Critical question. *If the sign of an interaction can be reversed by conjugating an interface without changing internal identity, how much of what we now call ‘charge’ is a property of the object, and how much is the geometry of access to it?*

14.16.3. POL-2 as the only candidate for emergent chiral neutrality

Among the four classes, POL-2 is the structurally privileged candidate for an external state without a unique chiral sign. The refinement introduced here is important: a vortex pole must not be confused with an elementary monochiral flow. In the proposed architecture, each tornado-type pole may have an internal chiral composition, because the coherent helical bundle may include antichiral components. Nevertheless, the pole may manifest its own functional chirality toward the exterior, determined by the dominant geometry of the bundle entering or leaving the cluster. Internal chiral composition and the pole's external chirality are therefore different levels of description.

[H] In POL-2, vortex poles may be organized into functional pairs in which one major region plays the IN role and the associated region plays the OUT role. The two regions may expose distinct external chiralities without either losing its internal chiral composition. The stronger hypothesis, which must be verified separately, is that the external chiralities of a stable local pair are conjugate. Viewed at the next higher scale, such a pair behaves as a single complete vortex cell: IN – internal path – OUT. POL-2 thus becomes a multipolar architecture composed of several such local vortex units, tightly bundled around the cluster.

[H] $\mathcal{V}_k = T_{\text{IN}, k}(\chi_k) \oplus T_{\text{OUT}, k}(-\chi_k)$ [conjugate case of the functional pair]

The argument χ_k in this relation indicates only the pole's functional external chirality, not its internal composition. The pair $\mathcal{V}_k$ has a complex internal chiral composition and is functionally bipolar at the IN–OUT level; several such cells may form the global multipolar distribution without the ensemble necessarily acquiring a unique chiral sign. The relation $\chi_{\text{OUT}} = -\chi_{\text{IN}}$ is, at this stage, a structural hypothesis for the conjugate case, not an already demonstrated consequence of the definition of POL-2.

POL-2 $\approx \oplus_k \mathcal{V}_k$ with $\mathcal{V}_k$: IN $\rightarrow$ path $\rightarrow$ OUT

This formulation eliminates the need for a third chirality and avoids an important confusion. The fact that a pole has an internal chiral composition does not require its functional interface to lack a sign. At the local level, interaction depends on the pole's dominant external chirality and its axial role relative to the cluster. IN/OUT and chirality are distinct descriptors: in principle, there may be red-IN, red-OUT, blue-IN, and blue-OUT, under the chapter's graphical convention. In POL-2, global neutrality or indefinability arises only from the collective organization of many poles with distinct external chiralities.

$$\chi_{\text{ext},k} \in \{+1, -1\}, S_k \in \{\text{IN}, \text{OUT}\}, \text{ but } \text{POL-2}[\Xi\chi \approx 0] \text{ or } \text{POL-2}[\Xi\chi = \emptyset]$$

Neutrality is therefore neither the absence of interaction nor the cancellation of the internal dynamics of each pole. It is the absence of a determinable global chiral sign for the channel being analyzed. Each pole may remain vortex-like, active, and functional, and each local IN–OUT pair may transport. What is lost at the ensemble level is only the possibility of compressing this multipolar network into a single external chirality.

[H] POL-2 is not declared ‘neutral’ by definition. The claim is only that this multipolar organization, formed from vortex poles with internal chiral composition and distinct functional external chiralities, provides the most natural candidate for states in which the channel's $\Xi\chi$ becomes approximately zero or in which the global sign cannot be assigned. If the sign of electric charge is ever correlated with $\Xi\chi$, electrical neutrality cannot be deduced from this analogy alone. The model would need to reproduce charge quantization, its conservation, behavior under conjugation, and electromagnetic coupling. Until then, chiral neutrality remains a distinct geometrodynamical property.

Critical question. *If every POL can internally contain both chiralities yet still expose a distinct functional chirality at the input or output, where is the ‘sign’ actually located: in the constituent filaments, in the vortex bundle, in the boundary geometry, or only in the relationship between POL and the exterior? And if POL-2 becomes neutral only at the ensemble level, can neutrality still be treated as an elementary property of the constituent?*

14.16.4. External polarizability, susceptibility, and interface memory

The very fact that neutrality does not destroy the internal structure makes polarizability possible. A POL-2 cluster in an externally compensated state may already contain the degrees of freedom needed to respond to a stimulus. The environment need not create chirality from nothing or change the internal chiral composition of each pole; it may select the orientation, weight, opening, or accessibility of some IN–OUT vortex cells relative to others. Induced polarization thus becomes a reorganization of the external weights of the poles, not the emergence of chirality at the constitutive level.

$$\text{POL-2}[\Xi\chi \approx 0] \text{ —stimulus—} \rightarrow \text{reweighting / orientation } \{\mathcal{V}_k\} \rightarrow \text{POL-2}[\delta\Xi\chi \neq 0]$$

[D] For a stimulus type q , we define as a working descriptor the POL susceptibility of channel j as the initial linear response of external chiral order to the controlled perturbation $\mathcal{P}\text{ext}^\wedge(q)$. The index q is necessary because a magnetic, electrical, mechanical, or other stimulus generally has neither the same unit nor the same coupling mechanism.

$$\mathcal{X}_{\text{POL}}^\wedge(j, q) = [\partial\Xi\chi^\wedge(j)/\partial\mathcal{P}\text{ext}^\wedge(q)] \text{ at } \mathcal{P}\text{ext}^\wedge(q) \rightarrow 0$$

Two clusters in the same POL class may have the same interface topology and very different susceptibilities. This separates geometric class from the ease with which it is reconfigured. As the stimulus increases, the response may reach saturation, a situation in which the accessible degrees of freedom have been almost completely selected and further variation of the stimulus changes $\Xi\chi$ very little.

$$\partial\Xi\chi^\wedge(j)/\partial\mathcal{P}\text{ext}^\wedge(q) \rightarrow 0: \text{POL saturation for stimulus } q$$

After the stimulus is withdrawn, at least two regimes are possible. In the reversible regime, the interface returns to its initial neutrality. In the regime with memory, part of the asymmetry remains and remanence appears. If the response to the same instantaneous value of the stimulus depends on the previous path, geometrodynamical hysteresis of the interface appears.

$$0 \rightarrow \delta\Xi\chi \rightarrow 0: \text{reversible polarization}$$

$$0 \rightarrow \delta\Xi\chi \rightarrow \varepsilon \neq 0: \text{remanence}$$

$$\Xi\chi = F(\mathcal{P}\text{ext}, \text{history}): \text{hysteresis}$$

This sequence has established analogies, but analogy is not confirmation. The magnetization of a ferromagnetic material may involve the reorganization of magnetic domains and may exhibit remanence and hysteresis; the Sun's global magnetic field reverses polarity during the magnetic cycle, with a reversal of the polar field approximately every 11 years [34]. These phenomena are described by their own theories and do not validate POL. They nevertheless provide systems in which any new polarization model must show what additional prediction it produces relative to standard explanations.

An even more interesting case is mutual polarization. Two clusters without a global external sign may each perturb the other's interface. The interaction would not require either one to be polarized in advance; coupling may appear after mutual symmetry breaking, possibly beyond a distance or intensity threshold.

$$C_1[\Xi\chi\approx 0] + C_2[\Xi\chi\approx 0] \rightarrow \delta\Xi\chi_{,1} + \delta\Xi\chi_{,2} \rightarrow \text{selected coupling}$$

[H] There may be a threshold d_c or perturbation threshold $\mathcal{P}_c$ below which the response is elastic and reversible, and above which the interface enters another POL state or a metastable polarized state. This turns polarizability into a problem of transition, not merely amplitude.

Critical question. *If two globally neutral structures can mutually generate the state required for coupling, must the 'force' preexist the interaction in its entirety, or can part of it emerge from the mutual reorganization of the interfaces themselves?*

14.16.5. Interaction selection, relational states, and the inverse atomic problem

POL compatibility must not duplicate the compatibility formalism introduced earlier. The α ratio remains the already-defined hypothetical scalar filter, while the kernels remain the geometric coupling families. The new level must be introduced only to specify whether a particular combination of interfaces admits a channel and how robustly it does so.

[D] We denote by $\mathcal{AAB}(j)$ the admissibility of a POL channel of class j and by $\mathcal{CAB}(j)$ the degree of geometric compatibility of the interface, avoiding the symbols S and K , already reserved in this volume for axial direction and kernels.

$$\alpha \rightarrow \mathcal{AAB}(j) \rightarrow \mathcal{CAB}(j) \rightarrow \text{permitted geometric kernel}$$

$$\mathcal{AAB}(j) \in \{0,1\}; 0 \leq \mathcal{CAB}(j) \leq 1 \text{ [working descriptor]}$$

In this framework, IN and OUT are not absolute labels of an isolated constituent. They are transport roles at the boundary. On the same channel, what is OUT for one cluster becomes IN for the partner. The effective orientation of the exchange is finalized through interaction.

$$\text{OUT}_A \equiv \text{IN}_B \text{ on channel } A \rightarrow B$$

This clarification is important for any attempt to associate the model with microscopic binary states. Up/down must not be identified directly with IN/OUT. In quantum mechanics, spin has its own definition and rules. A legitimate geometrodynamics hypothesis must show, at most, that an observed binary state is selected by the combination of chirality, transport direction, and interface geometry.

$$(\text{POL-}i, \chi, \text{transport direction}, \Omega) \rightarrow ? \text{ binary-state selection}$$

An independent experimental reference is the CISS effect (chirality-induced spin selectivity), in which chiral structures can produce spin-selective electron transport [33]. [R] This result does not state that spin arises from chirality and does not validate the POL scheme. It nevertheless provides a stringent conceptual test: if the theory links chirality to selection of a binary state, it must reproduce at least the reversal symmetries and dependence on transport direction observed in chiral systems.

The same discipline must be applied to the proton, neutron, electron, quarks, and photon. None should be labeled directly 'POL-x' because of resemblance to a diagram. One must begin with observables and solve the inverse problem: what POL class or combination of classes, what chirality, what kernels, and what transitions could simultaneously reproduce the measured properties?

$$\text{observables} \rightarrow \text{constraints} \rightarrow \text{candidate POL} \rightarrow \text{cluster model} \rightarrow \text{new prediction}$$

Likewise, the terms bosonic and fermionic, used analogically for certain coupling regimes in the theory, must not be transformed through mere nomenclature into the bosons and fermions of the Standard Model. A physical correspondence would require deriving spin, statistics, and the relevant

symmetry rules. Until then, ‘bosonic regime’ and ‘fermionic regime’ remain internal geometric analogies of the model.

Critical question. *If particle properties can be reconstructed from an internal identity plus a finite set of interface states, how many of the labels regarded as fundamental today still need to be introduced independently?*

14.16.6. POL dynamics: transitions, directional neutrality, and interface spectroscopy

A static taxonomy is insufficient. The interface may migrate, repolarize, lose coherence, or pass between classes. Therefore, an important part of POL physics may be hidden not in the POL-i state, but in the POL-i $\rightarrow$ POL-j transition. Transitions must be treated as events with threshold conditions, permitted channels, and intermediate states, not as arbitrary drawings of the same structure.

[D] We provisionally introduce $\mathcal{T}_{ij}$ as a descriptor of an interface transition, dependent on stimulus, orientation, chirality and history:

$$\mathcal{T}_{ij} = \mathcal{T}(\text{POL-i} \rightarrow \text{POL-j} \mid \mathcal{P}_{\text{ext}}, \chi, \Omega, \text{history})$$

If certain transitions are impossible without reconnection or loss of memory, POL selection rules appear. If thresholds exist, elastic regimes and structural-transformation regimes appear. If the forward path differs from the return path, the transition produces hysteresis.

Neutrality itself may be anisotropic. A global mean close to zero does not require every direction to be neutral. The interface may conceal local multipoles that cancel only after integration over the entire solid angle.

$$\langle \Xi \chi(\theta, \varphi) \rangle \Omega \approx 0, \text{ but } \Xi \chi(\theta, \varphi) \neq 0 \text{ locally}$$

This yields a method of investigation that may provisionally be called POL spectroscopy. The system is excited in a controlled manner from different directions, phases, frequencies, and chiral states; the response is measured as a function of orientation and history. One does not seek an image resembling the polarization drawing, but a response signature from which the interface can be reconstructed through an inverse problem.

$$\mathbf{R} = \mathbf{R}(\theta, \varphi, \omega, \chi_{\text{stim}}, \text{history})$$

Roberved $\rightarrow$ interface transition $\rightarrow$ probable POL + parameters

[P] A real POL class must produce observable invariants: preferred directions, reversals under conjugation, thresholds, absent channels, remanence, hysteresis, or discrete transitions. A classification that produces no such measurable differences remains merely morphological.

Critical question. *If two structures have the same visible form but different POL spectra, which expresses the relevant physical identity: the drawing or the response?*

14.16.7. Shielding reinterpreted: redistributing access to flows

Shielding provides a more stringent test than polarization. In electromagnetic physics, established mechanisms exist through which charge distributions, induced currents, material permeability, or the superconducting state modify field distributions. [R] These mechanisms have standard explanations and do not confirm helical geometrodynamics. They nevertheless demonstrate a useful methodological principle: reducing a field in one region does not imply disappearance of the source; it may result from redistribution of boundary conditions and flux paths.

[H] In the POL scheme, ‘shielding’ may be redefined as the selective redistribution of access to a class of marginal flow. The system remains internally active, but $\mathcal{C}_{AB}(j)(\theta, \varphi)$ is modified so that a channel becomes weaker in one region and stronger or more accessible in another.

$$\mathcal{C}_{AB}(j; \theta, \varphi) \rightarrow \mathcal{C}'_{AB}(j; \theta, \varphi), \text{ internal source unchanged}$$

In this formulation, shielding is not synonymous with neutrality. Neutrality concerns the possibility of assigning a global chiral sign; shielding concerns the accessibility of a channel. A neutral system may interact strongly, while a polarized system may be weakly accessible from a particular direction. The two concepts must be kept separate.

Three regimes can thus be ordered without introducing three distinct fundamental phenomena: polarization, directional redistribution, and collimation. They differ in the degree to which the interface concentrates access in certain regions.

distributed interface → redistribution → directional shielding → collimation

[P] If POL shielding exists, its signature cannot be merely a decrease in amplitude at a point. It must be a differential map in space, dependent on orientation and reversible when the POL state is switched.

Critical question. *If interaction with the exterior can be moved from one region to another without the source disappearing, is 'force' exclusively a property of the source, or also a property of the geometry through which the source becomes accessible?*

14.16.8. The extreme limit: POL collimation and the gravitational-modulation hypothesis

The riskiest extension of this construction appears when the principle of shielding as redistribution is applied to the class hypothetically associated with gravity. In the present scheme, POL-A is multipolar and produces an almost omnidirectional peripheral network. Therefore, the transition from distributed POL-A to an interface with only a few external channels cannot be treated as a mere rotation. It would be a major topological reconfiguration and must specify what happens to the remaining flows: internal recirculation, reconnection, conversion into another class, or controlled decoherence.

[H] We define a collimated state POL-A[col] only as a limiting research regime, without declaring it a different, fifth polarization. In this hypothetical state, most marginal channels that are candidates for the gravitonic class would be redistributed, while only two residual axial channels would remain predominantly accessible to the exterior, one functionally IN and one functionally OUT. In the limiting configuration that deserves separate testing, both residual branches would be located in the half-space opposite the dominant attracting mass, while retaining the distinct functional directions IN and OUT; closure or recirculation of the remaining flows would have to be resolved within the structure. This geometry produces a strong angular prediction, but it is admissible only if the closure topology and the conserved quantity are explicitly defined.

POL-A —reconfiguration→ POL-A[col] $\approx$ {INaxial, OUTaxial} + redistributed flows

This hypothesis is not 'antigravity,' does not imply negative mass, and does not presume the disappearance of the interaction. The relevant prediction would be much narrower: if the gravitonic interaction depends on geometric access to the interface, then the same mass could exhibit an effective gravitational response dependent on the orientation of the POL state.

$$\mathbf{M} = \text{constant}, \mathbf{a}_g(\text{POL}; \theta, \varphi) = \mathbf{f}(\text{POL state}, \theta, \varphi)$$

In a local experiment, Earth provides a dominant direction of the gravitational field. If the two residual channels could be oriented in a geometry unfavorable to coupling with the attractor, the model would predict an anisotropic variation. A 180° inversion would be especially informative if the IN and OUT roles are not equivalent in coupling.

$$\Delta \mathbf{a}_g(\text{POL}; \theta) = \mathbf{a}_{\text{ON}}(\theta) - \mathbf{a}_{\text{OFF}}(\theta)$$

possible: $\Delta \mathbf{a}_g(\text{POL}; 0^\circ) \neq \Delta \mathbf{a}_g(\text{POL}; 90^\circ)$ and/or $\Delta \mathbf{a}_g(\text{POL}; 0^\circ) \neq \Delta \mathbf{a}_g(\text{POL}; 180^\circ)$

[R] Current physics provides no confirmed mechanism for material shielding of gravity, and published experiments on alleged 'gravity shielding' effects have not yielded robust independent confirmation [35,36]. For this reason, the formally preferable term here is anisotropic modulation of gravitational coupling or POL collimation of coupling, not 'gravitational shielding' in the sense of a shield that cancels gravity.

The hypothesis becomes scientific only after a selection law, a quantity conserved during reconfiguration, and an angular distribution calculated before the experiment have been derived. Without them, the two axial vortex-type channels remain a research image, not a complete prediction.

Critical question. *If the same mass, without changing its composition, produced a different gravitational response solely through controlled reconfiguration of the interface, what part of what we call 'gravitational coupling' could still be attributed exclusively to mass, and what part would belong to the geometry of access?*

14.16.9. The critical experiment and the falsification criterion

Such a powerful hypothesis must be tested by a protocol more stringent than that required for a simple weight anomaly. A balance alone is insufficient: electrical power, magnetic fields, electrostatic charges, convection, heating, vibrations, cable tensions, and mechanical forces may produce false signals. The primary observable must be denoted neutrally as Δa_{obs} , until all conventional contributions are quantified and eliminated. Only a reproducible residual, compatible with the geometric prediction and incompatible with the control explanations, may become a candidate for Δa_g .

[P] The critical prediction is not ‘weight decreases.’ The experimental prediction is the existence of a function $\Delta a_{\text{obs}}(\theta, \varphi)$ correlated with the POL state, with a predeclared maximum and minimum and, if required by the IN/OUT model, an asymmetry under axis reversal. Its interpretation as Δa_g is permitted only after electromagnetic, thermal, mechanical, aerodynamic, and instrumental contributions have been excluded at the stated uncertainty level.

[E] The minimum protocol must compare POL-OFF with POL-ON for the same mass and the same mechanical geometry; it must include a control configuration with comparable thermal dissipation, reversal of the power supply, complete rotation of the device, monitoring of electromagnetic fields, temperature, pressure, and vibrations, and at least two independent measurement principles. The expected angular curve must be registered before data acquisition.

[E] The recommended progression is gradual: magnetic and electrical tests come first, where fields can be mapped accurately and compared with Maxwell's theory; only a POL residual that survives standard modeling is sought. Only after the same geometry produces a reproducible orientation rule in controllable domains does transferring the protocol to gravity make sense.

[F] The POL gravitational-modulation hypothesis is rejected or severely constrained if the signal disappears after electromagnetic, thermal, and mechanical effects are eliminated; if it is not independently reproduced; if it does not follow the predeclared angular signature; or if the observed amplitude remains compatible with zero within an experimental sensitivity established before the test.

**POL geometry → selection law → predeclared $\Delta a_{\text{obs}}(\theta, \varphi)$ → experiment → physical attribution
→ confirmation or falsification**

The same logic must also be applied to microscopic hypotheses. If chirality is a candidate for sign, reversing chirality must reverse a calculable observable. If POL-2 is a candidate for emergent neutrality, an induced response and a threshold must be identified. If a binary state results from coupling, changing orientation must modify the selection according to a rule fixed in advance. There is no shortcut from an elegant analogy to a physical law.

Critical question. *What experiment could force the theory to say ‘I was wrong’? If the answer cannot be written before measurement, the hypothesis is not yet mature enough to claim a new fundamental mechanism.*

14.16.10. The cross-cutting consequence — from particle to interface

If these hypotheses withstand testing, their consequence is not that the proton, neutron, electron, atom, planet, and star are the same object at different scales. The statement would be more precise: the same interface grammar may reappear in systems with different material substrates, energies, timescales, and effective equations. Universality would belong to the rule of access, not to the identity of the objects.

POL-2 adds a specific recursive consequence here: two local vortex regions, one functionally IN and the other functionally OUT, may constitute a single transport unit at a higher scale. The same IN–path–OUT logic thus reappears within a multipolar polarization. Recursivity is not used as proof of universality, but as a structural requirement that can be traced across scales.

POL equivalence ≠ physical identity

For atomic physics, the decisive question thus becomes a problem of conceptual reduction. How many properties must be introduced as fundamental labels, and how many can be obtained from a smaller number of geometric degrees of freedom: internal identity, POL class, chirality, orientation, kernel, coupling state, and memory? If sign can become an interface property, neutrality an emergent multipolar state, and polarizability a controlled reconfiguration, then the inventory of primitive

properties might be reduced. If not, the POL formalism must accept the limit and remain a classification of flows.

[H] *This is the research direction opened here: interaction can be investigated not only as an effect of the source, but also as an effect of geometric access between two interfaces. In this formulation, ‘force’ becomes a candidate manifestation of transport compatibility, without established theories being declared false before a differential prediction exists.*

The next volume can begin precisely here: defining the POL fields, the $\Xi\chi$ descriptor and its domain of existence, transition dynamics, selection laws, collimation topology, and interface-control protocols. Only then can the questions posed here become equations, devices, and measurements. In the present volume, the role of the chapter on polarizations is to establish the hypotheses, separate them from established results, and show what must be measured for them to be rejected.

Critical question. *If what we call an ‘elementary particle’ is the stability of an internal identity, while what we call ‘interaction’ is the geometry through which that identity becomes accessible, should unification not be sought first in the algebra of interfaces and only afterward in the list of objects?*

14.17. Conclusion — from taxonomy to polarized fields

Taxonomy proposed classes, while the POL scheme proposes modes of distribution around a core. The transition from flow to field remains a bridge to be built: the distributions must be transformed into calculable fields and compared with known interactions.

From this perspective, the particle-cluster and the four POL families are a structural hypothesis. Magnetism, gravity, and edge effects are candidate domains for comparison, not confirmations of the POL-1, POL-A, or POL-B classes.

The next chapter can build the tree-like architecture from this point. *Once we understand that nodes and clusters are not isolated objects but systems with polarized marginal flows, it becomes natural to analyze how these inputs and outputs connect into roots, trunks, branches, and subbranches. The tree does not emerge from chaos. It emerges from compatible polarizations that find a common direction of distribution.*

15. The tree-like architecture of the Universe — clusters, vortex tubes, and recursive flows

15.1. The problem of scale — the analyzed system is never absolute

In the preceding chapters, the system was introduced as the fundamental object of analysis. Every description begins by delimiting a domain: we choose a system and establish its interior, exterior, inputs, outputs, and the processes that conserve its identity. This delimitation is necessary, but it must not be confused with an absolute limit of reality. *The delimited system is always chosen at some scale.*

If we choose a cluster as the system, it may be analyzed as a localized particle, a skein of flows, a region of coherence, or a polarized node. If, however, we descend in scale, the same cluster no longer appears as an ultimate unit, but as an ensemble composed of smaller flows, filaments, subfilaments, and constituent microclusters. If we ascend in scale, the same cluster may become a constituent of a larger flow, a vortex tube, a branch, or a higher-order conglomerate.

Consequently, there is no single privileged level at which reality becomes definitive. There are levels of organization. What is a system at one scale may become a subsystem at the higher scale and a composite ensemble at the lower scale. This mobility of scale does not weaken the theory, but gives it continuity: the same principle of organization can be followed upward and downward, from microstructures to cosmic architectures.

Here the true meaning of tree-like architecture appears. The tree is neither merely a biological analogy nor a simple graphic branching scheme. The tree is the global form acquired by the recursivity of flows when a system at a given scale is composed of smaller-scale systems and, in turn, becomes constituent material for larger systems.

[H] **Fundamental principle — mobile scale**

A geometrodynamic system chosen at any scale is simultaneously a result and constituent material. It is the product of lower-scale flows and may become the element from which higher-scale flows are formed.

15.2. The cluster as product and constituent material

In the preceding chapter, the cluster was described as a polarized conglomerate. It is not an inert point, but a local agglomeration of helical flows organized around a core and surrounded by marginal flow fields. These marginal flows may belong to different classes and manifest distinct polarizations: POL-1, POL-2, POL-A, or POL-B. In this sense, the cluster is a local unit of coherence, but not an absolute unit.

A cluster exists because several flows succeed in stabilizing together. They gather, wind, compensate, distribute their torsion, and organize their marginal fields. From the outside, this organization may be perceived as a particle, a small body, a field node, or a material element. From the inside, it is an ensemble of flows. This dual nature must be preserved in our theory: the cluster is an object for the observer, but a process for geometrodynamics.

Here an essential idea appears. The cluster is not merely the result of lower-level flows. At the next scale, it becomes a working particle, a transport element, a grain of flow. Just as a grain of sand may be a separate object at one scale and granular material in a larger slide, a cluster of vortices may be a local system at one scale and a constituent of a vortex tube at the higher scale.

In a schematic representation, the relationship may be written as follows:

lower-level flows $\rightarrow$ scale- n cluster $\rightarrow$ constituent of the scale- $(n + 1)$ flow

This relationship must be read recursively, not linearly. Through instability, polarization, branching, or local decoherence, a higher-scale flow may generate new higher-scale clusters. These clusters may then enter still larger flows. Through the alternation between agglomeration and transport, the Universe becomes an architecture of flows that produce clusters and clusters that produce flows.

[H] Proposition of cluster-flow recursivity

Every coherent cluster is the product of a lower-scale flow and may become a constituent of a higher-scale flow.

15.3. The vortex tube as a composite structure

The vortex tube was previously presented as the minimal geometrodynamic system of helical flow. It has an axis, direction, chirality, core, vortex lines, IN, path, and OUT. Nevertheless, this description must not turn the tube into an empty or abstract entity. The vortex tube is built from something. In the Unified Theory, that something consists of filaments, which in turn are agglomerations of helical flows of lower-scale clusters.

A mature tube is not a simple line. It is a bouquet of vortex lines, a topological structure with linking, twisting, and writhing. In the language of helicity, it contains L_k , T_w , and W_r , namely different ways in which its constituent lines intertwine, twist, and undulate their axes. This internal organization shows that the tube has distributed memory. Memory does not belong to a single point, but to the ensemble of relationships among the components.

If the tube is composite, its stability cannot be reduced to the stability of an ideal axis. Stability is the result of cooperation among components. The constituent filaments can take up tension, transfer helicity, and locally modify radius, pitch, and orientation while the ensemble preserves global identity. When this cooperation succeeds, the tube remains coherent. When cooperation fails, decoherence or fragmentation appears.

This internal composition also explains why the tube can generate roots and branches. If a tube were a single line with no interior, branching would be merely a break. But if the tube is an ensemble of constituent flows, part of its organization can be redistributed into a root or branch without the entire process being immediately reduced to destruction. Branching thus becomes an adaptive solution, not an external accident.

Consequently, the vortex tube must be viewed as a recursively composite structure: at the scale being analyzed it is a coherent flow, but at the lower scale it is an ensemble of smaller flows. This dual reading prepares the emergence of the tree.

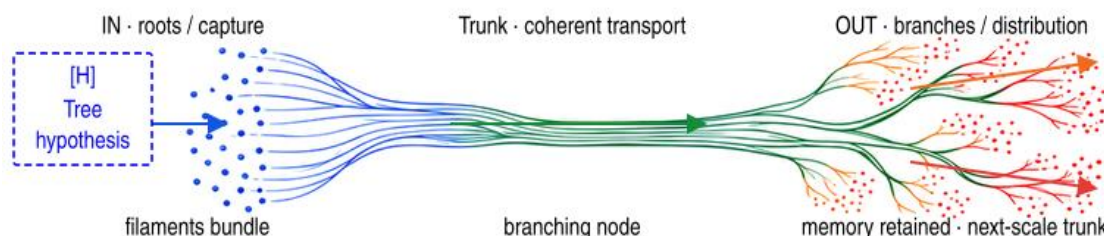
15.4. From filaments to the tree

When several filaments organize into a tube and the tube develops roots and branches, the first tree-like form appears. A branch (or root) is not a mere lateral deviation. It is a functional redistribution of transport, helicity, and internal memory. The trunk preserves the dominant direction, while the branches take up part of the flux, part of the geometric tension, and part of the function of communicating with the environment.

This architecture may be read through the IN–transport–OUT triad. Roots correspond to zones of capture, loading, and convergence. The trunk corresponds to the coherent transport zone, where the flux is stabilized and conducted axially. Branches correspond to zones of unloading, distribution, and emergence. This analogy is not decorative; it expresses the way flow organizes exchange between interior and exterior.

Nevertheless, tree-like structure must not be confused with the botanical tree. The botanical tree is only a macroscopic manifestation of a more general rule. In the Unified Theory, the tree is the architecture of a flow that can no longer be described by a single axial path, because its transport must distribute, collect from several zones, supply, or discharge in several directions.

A branch may become the trunk for subbranches. At another scale, a root may be a subroot of a larger system. A branching node may be analyzed as a polarized cluster, and a polarized cluster may become the starting point for new tubes. Thus, the tree is not a fixed structure, but a structure of scale. It is rewritten according to the level at which we choose the system.



The tree proposition

A helical flow becomes tree-like when its coherent transport is recursively distributed among roots/subroots, trunks, and branches/subbranches, while preserving a relationship of origin and memory among the components.

15.5. Geometrodynamical recursivity

Recursivity is the mechanism through which the same organizational logic reappears at different levels. It does not mean identical repetition. A microscopic tube, a biological vessel, a tree trunk, a cosmic filament, and a galactic network are not the same object. Nevertheless, they may express the same rule: flows that organize into zones of absorption, roots, trunks, branches, nodes, and distribution zones.

At one scale, we observe clusters linked helically. At the next scale, this chain may be perceived as a filament. Several filaments may compose a tube. Several tubes may compose a bundle. Bundles may produce nodes. Nodes may generate trees. Trees may form networks. A network observed from a still larger scale may again become a single transport system.

The scheme may be expressed simply:

clusters → filaments → tubes → bundles
→ nodes → trees → networks → higher-scale systems

This succession is not necessarily linear in every case, but expresses the general direction of construction. A level may be skipped, compressed, fragmented, or reconfigured. What matters is the alternation between localization and flow: what stabilizes locally becomes material for new transport, while what is transported coherently may produce new localizations.

In this framework, the particle is no longer the endpoint of explanation. It is a local state of recursivity. The body is no longer an inert aggregation of particles, but an architecture of flows stabilized across levels. The field is no longer merely a function assigned to space, but the marginal and extended distribution of flows through which clusters interact at a distance.

Geometrodynamic recursivity permits passage from micro to macro without changing the principle. Scale, density, speed, stability, polarization form, and the values of the constants change, but the same logic remains: flows that build clusters and clusters that build flows.

15.6. Nodes — polarized clusters as points of scale change

In the tree-like architecture of the Universe, the node must not be understood as an element different from the cluster. Nodes are clusters, but they are called nodes when analyzed in relation to a network, a tree, or an extended flow structure. The same vortex agglomeration may be viewed locally as a cluster and structurally as a node in a transport network. The difference is not one of nature, but of function and level of analysis.

The cluster describes local coherence. The node describes the role of that coherence within the ensemble. Therefore, a node is a polarized cluster that participates in the distribution, selection, conversion, or branching of helical flows. It is not merely a meeting point between branches, but an active geometrodynamic region in which flows enter, are evaluated for compatibility, and are then redistributed toward other directions, other branches, or other levels of scale.

The preceding chapter showed that a conglomerate has inputs, outputs, and polarized marginal fields. In a tree-like architecture, these characteristics become decisive. A node receives flows, organizes them at its own scale, and may transmit them onward. For this reason, the node is one of the places where geometrodynamic recursivity begins to become visible: flows produce clusters, clusters function as nodes, and nodes may become constituents of larger flows.

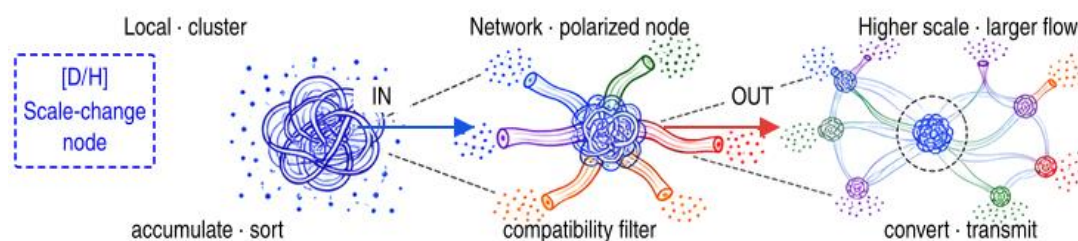
A polarized node does not redistribute every flow in every direction. Under the theory's hypothesis, selection depends on the flow class, chirality, axial direction, phase, relative orientation, proximity of the independent vectors, and kernel dynamics. Compatibility through α is only a preliminary scalar filter. The consequences—integration, deviation, absorption, or reconfiguration—must be derived from an evolution law and then tested.

Through this function, the node becomes a gate between localization and transport. As localization, it is a cluster. As a network function, it is a node. It accumulates, sorts, converts, and transmits. Therefore, localization and transport must not be treated as two opposing realities. The node localizes precisely in order to redistribute. It concentrates flows so that it can reorder them, and this reordering allows the tree to preserve its global coherence.

In a mature tree, not all nodes have the same function. Some are capture nodes associated with IN regions, where dispersed flows are gathered and oriented. Others are transit nodes, where transport is stabilized without a major change of scale. Others are distribution nodes associated with OUT regions, where the principal flow branches and is transmitted to secondary systems. There are also polarization nodes, where flows are ordered by chirality and class; conversion nodes, where a flow changes regime; and reconfiguration nodes, where the old geometry can no longer be conserved and a new structure appears.

In this sense, the node is the geometrodynamic organ of the tree. Within the global structure, it fulfills the role that the cluster fulfills at the local scale: it maintains coherence, preserves memory, manages interactions, and determines continuity. Yet when viewed as a node, the cluster is no longer analyzed in isolation, but through its relationships with the roots and branches entering and leaving it.

This distinction is essential for understanding mobile scale. When we descend below the level of a node, we discover that it consists of smaller flows, filaments, and clusters. When we ascend above it, the same node becomes a point in a larger flow, a root/branch of a tree, or a component of a higher network. Thus, the node is simultaneously result and beginning: the result of the flows that form it and the beginning of the flows in which it is engaged.



Consequently, in the Unified Theory, nodes are not mere geometric intersections. They are polarized clusters integrated into a transport architecture. They mark the places where matter, energy, and geometrodynamical information can pass from one scale to another. The tree is not built from empty lines, but from such active nodes, and each node carries within it the memory of the flows that formed it and the possibility of the flows it will generate.

The node is the cluster viewed within the network. The cluster is the node viewed locally.

15.7. Memory distributed across the tree

If a vortex tube has topological memory, then a tree has distributed memory. This memory is not concentrated in a single branch, a single node, or a single center. It is distributed through the way the trunk, roots, branches, and nodes preserve their relationships of connection, continuity, and compatibility.

Branches arising from the same trunk are not absolutely independent. They participated in the same initial flow state, the same distribution of helicity, and the same separation process. Even if they move apart and evolve differently, they preserve a trace of structural compatibility. This trace may be topological, kinematic, informational, or expressed through similar values of the state constants. The same applies to the selective convergence of roots through their evolving approach to the trunk and their connection with it.

Distributed memory does not mean that all branches/roots are identical. On the contrary, the tree exists precisely because branches/roots differentiate. One root/branch may transport more mass, another more torsion, another more coupling information. Yet differentiation remains connected to the ensemble as long as the system can conserve global coherence.

This idea is essential for the next chapter. Tree-like kinematic correlation cannot be introduced as a magical connection between separate objects. It must be prepared through this distributed memory: if two branches or two roots belong to the same trunk and preserve state compatibility, then perturbing one may require compensations within the shared architecture.

[H] Tree-memory proposition

Branches arising from the same trunk may evolve differently, but they preserve a relationship of origin, compatibility, and distributed memory that permits correlations at the level of the entire tree. Roots likewise may evolve differently yet selectively, correlated with the memory of the trunk.

15.8. Coherent branching and incoherent fragmentation

Not every break in a flow produces a tree. Not every multiplication produces coherence. This distinction is needed to avoid confusing branching with fragmentation. Coherent branching occurs when part of the transport and memory is redistributed into secondary structures that preserve a functional relationship with the trunk. Incoherent fragmentation occurs when this relationship is lost.

In coherent branching, the new branch may have its own identity, but remains connected to the ensemble through origin, compatibility, and function. It is not discarded residue, but a new transport channel. It may take up flux, release tension, supply another node, or become a secondary trunk. In this case, the tree grows without completely losing its initial memory.

In incoherent fragmentation, the old flow fails to distribute tension in a compatible way. Separate structures, local turbulence, unstable vortices, or flows that can no longer conserve the same set of constants appear. This is the region of decoherence. Matter and motion do not disappear, but the identity of the initial system is lost.

In the model, the difference between the two situations is determined by preservation of the distributed state. If the branches remain within the tolerance of the vector $(C_c, C_r, \eta, S, \chi, \phi)$ and the topological constraints, the ensemble may be treated as a tree; departure from tolerance describes fragmentation or reconfiguration. α may be reported only as a derived diagnostic. The selection of roots in the convergence zone is analogous.

This distinction is also important at the cosmic scale. A filamentary network may be coherent if its roots, nodes, branches, and flows preserve relationships of selection and distribution. But a cloud of fragments is not a tree merely because it has many parts. The tree requires a common trunk, orientation, memory, and function.

15.9. Tree-like architectures in nature

Nature offers numerous images of tree-like structure: roots, branches, blood vessels, bronchi, nerves, rivers, lightning, fungal networks, and cosmic filaments. These examples must not be used as simple evidence from visual resemblance. They are important because they show the recurrence of a solution: when transport must collect, distribute, supply, or discharge within a volume, geometry branches.

In biology, the vascular or neural tree is not ornament. It is a solution for transport and communication. In hydrology, a drainage basin is not an accidental drawing. It is a solution for collection and discharge. In the atmosphere, electrical discharges do not branch capriciously, but because the potential difference seeks connecting paths. In cosmology, the filaments and nodes of large-scale matter suggest that cosmic distribution too can be read as a network of transport and accumulation.

The Unified Theory does not claim that all these systems are identical. It claims that all may express the same geometrodynamic logic: flows that organize in tree-like form to manage potential differences, transport, accumulation, and distribution. Each domain has its own material, scale, and operational laws, but the tree-like form indicates a common geometry of transport.

This observation allows microstructures to be linked with macrostructures without forcing their identity. A microscopic vortex tube, a biological filament, and a cosmic filament are not the same system, but they may be read through the same language: clusters, nodes, branches, trunks, marginal flows, polarization, and distributed memory. At each scale, we choose the system and follow how it is built from lower-level flows and how it contributes to higher-level flows.

Is it possible that all living beings develop tree-like circulatory systems during their early stages?

The tree thus becomes the general form of recursive connectivity. It shows how the Universe can build extended structures without abandoning the local logic of the vortex cluster.

15.10. The tree as a support for kinematic correlation

Here the hypothesis of a specific causal connection is formulated: tree-like kinematic correlation. To introduce it correctly, its structural support must now be established. Kinematic correlation does not arise between any two objects arbitrarily chosen from the Universe. It can be observed only where there is common origin, common memory, or membership in the same flow architecture.

If two branches arise from the same trunk, they are not completely independent. The same holds for two roots converging toward the same trunk. If two particle-clusters appeared from the same parent flow, they preserve compatibilities not reducible to the distance between them. The same holds for two others that feed the flow. If two nodes belong to the same tree-like network, a local perturbation may require global redistributions of state. This does not mean classical signal transport from one to the other, but reconfiguration of a shared structure.

Therefore, the tree is the condition that makes kinematic correlation intelligible. Without the tree, two particles appear as separate objects. With the tree, they may be read as roots, branches, ends, or nodes of a common geometrodynamic history. Distance does not disappear, but it is no longer the sole criterion of connection. Origin, memory, and compatibility become equally important.

This interpretation preserves continuity with the preceding chapters. F.T.W. described the local transmission of a perturbation between compatible flows. The tree-like architecture describes the support on which such local perturbations may become extended distributions. Kinematic correlation will describe the tree's global response when one of its roots or branches is modified.

The logical sequence is therefore:

local F.T.W. → coherent tree → helical kinematic correlation

In this way, kinematic correlation is no longer introduced as a mystery, but as a mature effect of recursivity, common origin, and distributed memory.

15.11. Conclusion — the tree as the global form of recursivity

Tree-like architecture is not an external addition to the theory of helical flows. It follows naturally from the fact that the system may be chosen at any scale. Descending in scale, we discover that the vortex tube is composed of filaments, clusters, and constituent flows. Ascending in scale, we discover

that these clusters may become elements of larger flows, while larger flows may generate nodes, branches, and networks that constitute much larger helical flows.

This perspective eliminates the rigid opposition between particle and field, object and process, local and global. The particle-cluster is the localization of a flow. The marginal field is the distribution of flows around the cluster. The vortex tube is the coherent transport of constituents. The tree is the global form through which transport branches, distributes, and preserves its memory.

In the Unified Theory, the Universe is not built from separate objects that merely receive motion from outside. It is built from flows that locally agglomerate into clusters, while the clusters become the material of higher-scale flows. This alternation between agglomeration and transport, node and branch, localization and distribution, produces the tree-like architecture of natural systems.

The chapter's central formula may be written as follows:

flows → clusters → higher flows → higher clusters → trees → networks

The tree is therefore the global expression of geometrodynamical recursivity. It prepares the understanding of helical kinematic correlation, because only a structure with common origin, differentiated branches, and distributed memory can respond globally to a local perturbation.

Chapter synthesis: the recursivity introduced in Chapter 1 acquires an architectural expression here. The particle-cluster may become an element of a higher-scale flow, while the vortex tube may become a branch, trunk, or network within a larger tree-like structure.

16. Tree-like kinematic correlation — classical analogue and support hypothesis

16.1. From the tree to kinematic interdependence

The preceding chapter established that tree-like architecture must not be understood as a simple botanical analogy. The tree is the global expression of geometrodynamical recursivity: flows form clusters, clusters become constituents of higher-scale flows, and these flows may generate new clusters. In this succession, what appears at one scale as a localized particle becomes, at the next scale, a component of a branch, trunk, or extended network.

This idea radically changes the problem of long-distance connections. If two clusters are viewed as isolated objects, any correlation between them appears mysterious. But if the same clusters are understood as branches, ends, or nodes of a common architecture, correlation no longer appears as magical action between two separate points, but as an effect of the internal interdependence of the system from which they arise.

Current physics — Quantum entanglement is defined in Hilbert space and produces measurement-basis-dependent correlations consistent with the Born rule. Bell/CHSH experiments rule out local models with predetermined outcomes, and the correlation does not permit superluminal signalling. [20–24]

Theory proposal — *The vortex tree provides a model of distributed classical correlation based on common origin, dynamic links, and global compensation. The internal expression ‘helical kinematic entanglement’ denotes only this analogue and does not automatically identify it with quantum entanglement.*

Missing bridge — For identification with quantum entanglement, the common state, observables, choice of bases, joint probabilities $P(a, b|x, y)$, the Born rule, and the mechanism that exceeds the CHSH bound without signalling must be defined.

[F] Test criterion — The model must calculate the correlator $E(x, y)$ and the parameter S_{CHSH} . If it always satisfies $|S| \leq 2$, it is a valuable classical analogue, but not an explanation of the observed quantum entanglement.

In a vortex-type tree, the roots and branches are not completely independent. They may have different directions, cross different regions, become local nodes, or generate secondary clusters, yet they retain a relationship with the trunk they enter or from which they originate. This relationship is not merely selective for roots or historical for branches. It is kinematic: the roots and branches participate in

the same memory, the same global transport architecture, and the same need to preserve the coherence of the whole.

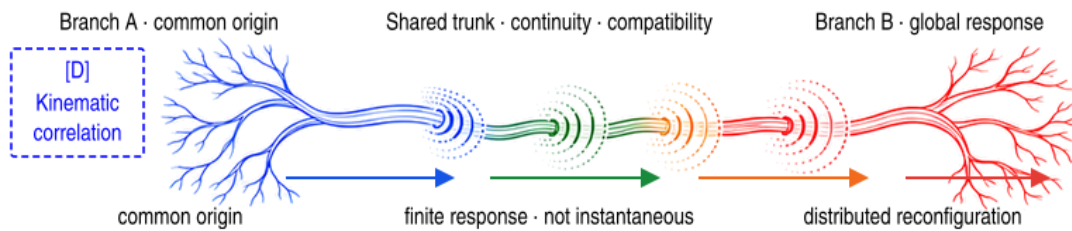
From this arises the concept of tree-like kinematic correlation. It describes a shared flow structure in which a local perturbation may produce distributed readjustments at finite speed and through specified dynamics. This is a classical system correlation; the connection with quantum entanglement remains a separate hypothesis.

Therefore, kinematic correlation must be placed within the logic of tree-like architecture. We cannot speak rigorously of deep correlation before knowing the common-trunk structure on which this correlation occurs. The tree is the support. Kinematic correlation is its distributed response.

16.2. Definition of tree-like kinematic correlation

In the Unified Theory, the internal expression ‘helical kinematic entanglement’ denotes the geometrodynamical interdependence among two or more branches, roots, filaments, nodes, or clusters of the same flow architecture. Throughout the rest of the chapter, the mechanism is called tree-like kinematic correlation: perturbing one component requires a distributed reconfiguration of the whole, with finite dynamics and speed.

This definition has four mandatory elements. The first is the common trunk. Without a common trunk, we are not speaking of kinematic correlation, but of ordinary interaction between different systems. The second is structural continuity, even if it is no longer visually evident. The third is state compatibility, expressed through constants, chirality, axial direction, polarization, and coupling. The fourth is the system's capacity to respond globally to a local perturbation.



Kinematic correlation does not imply instantaneous transmission. The model must specify the speed and equation of the response within the common structure. If the response is local and causal, it cannot by itself reproduce a Bell violation; if it is nonlocal, compatibility with no-signalling and relativity must be demonstrated.

A conceptual formulation may be written as follows:

$$C_{arb}(A, B) = 1 \text{ if } O_{AB} = 1 \text{ and } \mathcal{D}[\mathcal{S}(A), \mathcal{S}(B)] \leq \epsilon;$$

this is a classical membership rule.

In this relation, O_{AB} expresses the common trunk of the two structures, while $\Delta\mathcal{S}_{AB}$ represents the difference between their relevant geometrodynamical states. If the common trunk is absent, there is no kinematic correlation. If the state difference exceeds the compatibility threshold, the common link degrades and the system enters a regime of decoherence or ordinary interaction.

This formula should not be regarded as a final equation, but as a reading rule. It shows that kinematic correlation is reducible neither to distance nor to external resemblance. Two structures may be close and yet not deeply correlated. Two structures may be far apart and yet correlated if they are part of the same recursive flow architecture.

16.3. The common trunk — condition of tree-like correlation

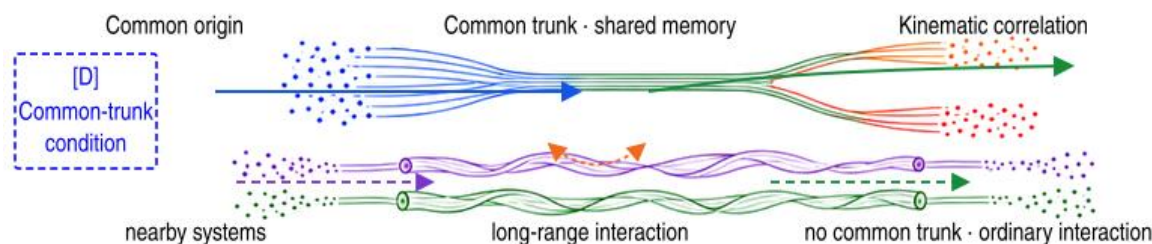
The common-trunk condition is decisive. In the Unified Theory, a kinematic-type correlation does not arise between just any two structures. It arises between structures generated by the same process, the same trunk, the same parent flow, or the same convergent–divergent IN–OUT event. This structural transport link between IN and OUT gives them a common initial memory, even if the roots and branches differentiate.

If two clusters approach one another and interact through compatible marginal flows, there may be attraction, repulsion, repolarization, filtering, or capture. This is interaction. But it does not automatically

result in kinematic correlation. *Kinematic correlation requires more than mutual influence. It requires membership in the same geometrodynamic transport construction.*

This distinction is important so that long-range interactions between fields are not confused with kinematic correlation. Two magnets may interact through their magnetonic classes and simultaneously have gravitational interaction through their gravitonic classes. This interaction may be strong, ordered, and predictable, but it is not kinematic correlation. It becomes kinematic correlation only if the two structures are roots, branches, or local manifestations of a common architecture preserved from a process of origin.

Therefore, in the language of this theory, three levels must be separated: local contact, long-range interaction, and kinematic correlation. Local contact entails proximity and immediate transfer. Long-range interaction entails fields of marginal flows, compatible classes, and polarization. Kinematic correlation additionally entails a common trunk and a global constraint preserving the state of the whole.



The central sentence of this chapter may be stated simply: kinematic correlation does not connect unrelated objects; it preserves the correlation between branches of a common trunk.

16.4. Roots, branches, nodes, and clusters within the same common structure

The chapter on nodes established that nodes are clusters viewed within a network, while clusters are nodes viewed locally. This dual reading becomes essential for understanding kinematic correlation. A particle-cluster may appear as a localized point to an observer, but within the geometrodynamic structure it may be a node, a branch end, a bifurcation, or a fragment of the memory of a larger flow.

If we choose the system at a certain scale, we may descend and discover that it consists of lower-scale flows. We may ascend and discover that the same system is part of a higher-scale flow. This mobility of scale shows that kinematic correlation should be sought not only between particles, but between positions in a recursive architecture. What is correlated is not material balls, but local states of the same distributed flow.

A node may receive flows from multiple branches, with its roots selecting them by class, chirality, and polarization, and may then emit them in another configuration. If two branches originate from the same node, they remain connected through the memory of that node. If two clusters appear as outcomes of the same branching, they carry a relationship of origin that cannot be fully described merely by the distance between them.

[H] Under the hypothesis of a coherent, coupled system, a local event may produce distributed responses according to a finite propagation law. Perturbing a node would modify the distribution of flows in roots and branches, while perturbing a component would place a demand on the node of origin. This defines the proposed kinematic analogue; it does not imply instantaneous influence and does not reproduce quantum entanglement without calculation of Bell correlations.

Therefore, kinematic correlation arises where the local still belongs to the global. If the local breaks away completely from the global, interaction remains, but kinematic correlation is lost.

16.5. The two-direction mechanism: transverse coupling and axial adaptation

The mechanism of helical kinematic correlation may be described through two complementary directions. The first is the transverse direction, through which a perturbation passes from one root, branch, filament, or flow to another. The second is the axial direction, through which each affected component adjusts its own internal continuity along its path.

Transverse coupling naturally belongs to the C–C regime. Two neighboring flows or two filaments in the same bundle do not have to merge axially in order to influence one another. They may laterally

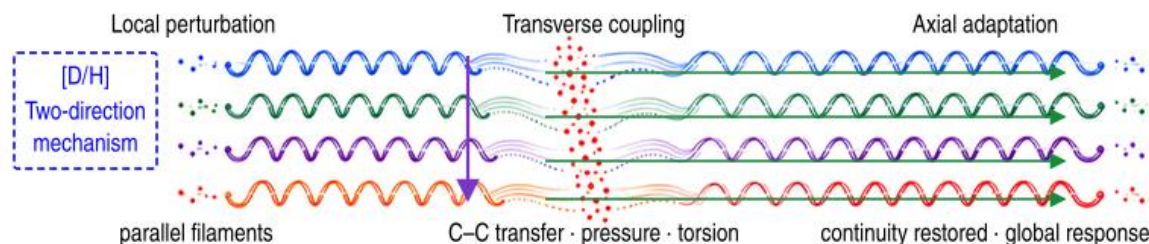
transmit geometric pressure, drift, torsion, phase orientation, or modification of the marginal field. This lateral transmission is subtle: it does not yet mean the emission or absorption of structure, but the transfer of a perturbed state.

Axial adaptation occurs after the perturbation has entered each affected component. A laterally perturbed filament cannot remain modified only at the point of contact. To preserve its identity, it must redistribute the adjustment along its own axis. Thus, a change introduced transversely becomes an internal axial response.

This dual direction may be formulated as follows:

$$\delta S = \delta S_{\perp} + \delta S_{\parallel}$$

The component $\delta S_{\perp}$ represents the perturbation transmitted transversely between roots, branches, or filaments. The component $\delta S_{\parallel}$ represents the axial adaptation through which each element restores its continuity. Kinematic correlation arises when these two processes do not remain local, but close into a coherent reconfiguration of the entire tree.



Here the connection with the Fundamental Torsion Wave becomes visible. The F.T.W. was defined as a drift dynamic produced by lateral deflection and then transmitted axially within the structure of each affected vortex. Kinematic correlation uses the same principle, but at the level of the tree-like whole. *F.T.W. is the language of the perturbation; kinematic correlation is the response of the common structure to that perturbation.*

16.6. Common memory and geometrodynamic compensation

Kinematic correlation cannot be understood without the concept of geometrodynamic memory. One branch is not linked to another merely because they once existed near each other on a common trunk. Likewise, one root is not linked to another merely because they approach a common trunk. They remain linked because they participate in the same transport state, the same flow distribution, and the same need to preserve the whole.

This common memory does not mean perfect uniformity. Two branches originating from the same flow may become different. One may transport more geometrodynamic mass, another more perturbation information. One may become more axialized, another more branched. One may enter a repolarization node, another a distribution node. The same applies to roots. Differentiation does not automatically break the common-trunk structure. *It becomes dangerous only when the difference exceeds the structure's compatibility threshold.*

In a coherent whole, modification of one branch must be compensated. If one branch takes up more torsion, another part of the system may modify its phase, radius, pitch, orientation, or distribution of marginal flows. If one branch loses coherence, the common node may redistribute transport. The same mechanism applies to roots. If a cluster polarizes differently, the marginal fields of the whole may attempt to rebalance compatibility.

This compensation is not a conscious choice by the system. It is a consequence of conservation. A coherent system cannot allow a local perturbation to destroy global memory immediately. It first attempts to distribute it. If distribution succeeds, kinematic correlation is preserved. If distribution fails, decoherence occurs.

In this sense, kinematic correlation is the kinematic form of the obligation to compensate. Branches and roots with a common structure are not free to behave as though they did not belong to the same trunk. As long as the common structure exists, modifying one calls for the readjustment of the others.

16.7. Correlation and flow classes: compatibility, not absolute identity

A possible error would be to believe that this kinematic correlation requires all the branches or all the clusters involved to be identical. The Unified Theory requires something else: compatibility. Two kinematically correlated structures may have different local values, play different roles in the tree, and display different polarizations, but they must remain linked through a common memory and a compatible coupling framework.

Compatibility may be read through several criteria: flow class, α state, axial direction, chirality, polarization, and role in the IN–transport–OUT architecture. If these criteria remain within the domain of coherence, the system may preserve kinematic correlation even if the roots and branches have differentiated. If they leave the domain of coherence, the relationship becomes unstable.

This idea is important because the tree is not a uniform object. A mature tree contains roots, a trunk, branches, subbranches, capture nodes, distribution nodes, polarization nodes, and reconfiguration nodes. *If kinematic correlation required uniformity, such a tree could not exist. It exists precisely because local differences are maintained within global compatibility.*

We may therefore say that this kinematic correlation is not equality of form, but dependence of state. Two branches may have different forms, but if modifying one enters the balance of the other, they are correlated. The same applies to roots. Two clusters may exist far apart, but if they belong to the same common-trunk constraint and respond to the same need for conservation, they remain kinematically correlated.

This compatibility links kinematic correlation with geometrodynamical Darwinism. Not every root or branch survives within a common structure. The branches that persist are those able to differentiate their function without breaking the memory of the whole.

16.8. Measurement, the detector, and the breaking of common coherence

In quantum theory, measurement is a physical interaction described through operators, composite systems, and decoherence; no mental action is required. The Unified Theory may model the detector as a coupling system, but it must derive outcome probabilities and measurement-basis dependence.

When a detector couples to a kinematically correlated branch, it introduces a new interaction architecture. The branch no longer responds only to the common trunk, but also to the detector's nodes, marginal fields, and absorption thresholds. This coupling may reorient the flow, select a polarization, absorb part of the state information, or transform a subtle perturbation into a measurable local event.

Therefore, measurement does not destroy a mysterious link merely because someone looks. It may break or filter common coherence because it adds a new coupling system. The detector becomes an external node. It forces the measured branch into another compatibility relationship. If this new relationship is stronger than the link with the original tree, kinematic correlation degrades.

This degradation may be called geometrodynamical decoherence. Decoherence does not mean the disappearance of matter or flow. It means the loss of the common state that allowed the branches to respond as parts of the same system. After measurement, the branch may continue to exist, but it no longer belongs to the original whole in the same way.

This interpretation preserves the detector as a physical system, in agreement with modern descriptions of decoherence. The theory's specific contribution must be additional dynamics and a prediction, not merely the statement that the detector interacts with the system.

16.9. Kinematic correlation and interaction over much greater distances between clusters

A clear separation must be made between kinematic correlation and long-range interaction between clusters. In the Unified Theory, clusters may interact through their classes of marginal flows. A cluster may have magnetonic, gravitonic, stratified, or other classes of surrounding fields. Two clusters may be attracted, repelled, deflected, or polarized through the compatibility of these classes. This is long-range interaction.

Kinematic correlation is more restrictive. It requires a common origin. Two clusters that interact gravitationally are not automatically kinematically correlated. Two clusters that interact magnetically are not automatically kinematically correlated. Two clusters within the same marginal field are not

automatically kinematically correlated. They may simply be different systems influencing one another through compatible flows.

[H] Kinematic correlation through common origin is proposed for clusters that are not merely field neighbors, but outcomes of the same flow history. Such an origin may produce persistent classical correlations even at a distance, but does not by itself imply a present influence and cannot exceed the local Bell bound. Roots must not be neglected: common history, the dynamic channel, and propagation time must be modeled separately and tested.

This distinction protects the theory from terminological confusion. If every long-range interaction constituted kinematic correlation, the concept would become useless. Kinematic correlation must be reserved for situations in which the common transport structure, common memory, and conservation constraint of the whole are essential.

In brief: long-range interaction connects compatible systems; kinematic correlation correlates the roots and branches of the same system.

16.10. Kinematic correlation across successive scales

The mobile scale of systems shows that this kinematic correlation should not be conceptually limited to a single dimension of reality. What is a particle-cluster at one scale may be a constituent branch at the next scale. What is a vortex tube at one scale may become the trunk of a larger tree. What is a local node at one scale may become an element of a cosmic network.

Therefore, kinematic correlation may be read recursively. At a small scale, it may arise between clusters originating from the same flow. At an intermediate scale, between branches originating from the same trunk. At a large scale, between structures belonging to the same transport network. The mechanism does not change: common origin, state compatibility, distributed memory, and coherent reconfiguration.

This recursivity does not mean that all things in the Universe are kinematically correlated with all others in the same way. That would be too weak and too general a statement. Kinematic correlation has domains. Each domain is defined by the tree, trunk, or common flow from which the analyzed branches originate. When the domain breaks, kinematic correlation is lost or transforms into ordinary interaction.

In a geometrodynamic Universe, there are probably many levels of correlation. Some are local and strong. Others are extended and weak. Some are easily destroyed by detectors or the environment. Others are preserved by very stable structures. What matters is that the principle remains the same: deep correlation is explained not by spatial proximity, but by structural membership.

Thus, kinematic correlation becomes a principle of continuity across scales. It shows that visible separation does not automatically cancel the geometrodynamic unity of origin.

16.11. Limits of the analogy and the quantum criterion

To remain rigorous, the concept of helical kinematic correlation must be clearly limited. Not every resemblance is kinematic correlation. Not every long-range interaction is kinematic correlation. Not every weak influence between two systems is kinematic correlation. The minimum conditions are: a common trunk, state compatibility, distributed geometrodynamic memory, and the capacity for coherent reconfiguration of the whole.

If the common trunk is absent, there is only interaction. If compatibility is absent, there is stress, filtering, repulsion, or decoherence. If common memory is absent, there is coincidence or resemblance, not kinematic correlation. If the perturbation places no constraint on the whole, there is a local effect, not deep kinematic correlation.

[H] The working hypothesis may be formulated as follows:

[H] Two or more helical structures are defined in the model as kinematically correlated when they belong to the same geometrodynamic architecture, preserve state compatibility, and display measurable compensation of local perturbations through a defined channel and over a defined propagation time.

This formulation shows why kinematic correlation is a natural consequence of tree-like architecture. If the tree is real as a flow organization, then its roots and branches cannot be absolutely independent. Independence arises only after separation, after the loss of common coherence, or after the root/branch is integrated into a new dominant architecture.

The next chapter will address axialization. Kinematic correlation has shown how a tree reacts when a root or branch is perturbed. Axialization will show how a mature flow reduces its losses and stabilizes its transport so that such correlations can be maintained with minimal energy consumption.

Here is a concise formulation:

Tree-like kinematic correlation is the proposed property of roots and branches with a common trunk to respond through distributed compensation. It constitutes a testable classical analogue. Identification with quantum entanglement is permitted only if the model recovers the Born rule, basis-dependent correlations, Bell violation, and no-signalling.

17. Axialization — the limit of transport efficiency and coherent stability

17.1. Why must axialization be separated from the Σ_{gd} regime?

After the taxonomy of flows, the polarization of conglomerates, and the tree-like architecture of the Universe, the problem of axialization can be formulated unambiguously. *Axialization is not genesis, not the first systemic separation, and not the Σ_{gd} regime. It belongs to another stage in the life of a flow: the stage in which a system that is already born, already classified, and already integrated into a transport architecture reduces its losses, stabilizes its parameters, and orients its fundamental function in the direction of maximum efficiency.*

In the preceding chapters, the system was defined as a delimited domain of analysis, while helical flow was described as a privileged form of coherent transport. The Preda constants introduced the internal kinematic identity of the flow, the kernels described the fundamental modes of interaction, and geometrodynamics showed how a flow can remain the same over time even when its geometry changes. Geometrodynamics Darwinism added the criterion of selection through coherence, while taxonomy ordered flows by classes, species, and states. Polarization showed how a conglomerate distributes its marginal flows, while the tree showed how structures connect recursively across successive scales.

Only after this construction can axialization be understood correctly. It is neither the mere elongation of a vortex tube nor its reduction to a geometric line. *Axialization is the maturation of transport.* It denotes the process through which a coherent helical flow, subject to the conservation of its own constants and to interactions with the environment, organizes its flux ever more strongly around its functional axis. The axis is not merely a direction drawn in space, but the direction of minimum geometrodynamics stress and maximum continuity of transport.

Current physics — Helical flows and vortices are characterized by vorticity, helicity, the Reynolds number, swirl number, velocity profiles, stability, and dissipation. Greater axial orientation does not automatically imply maximum efficiency.

Theory proposal — Axialization is measured by the increase of $\eta = v_a/v_t$, the reduction of transverse dispersion, and the reduction of the reconfiguration rate for the same tracked profile.

Missing bridge — The relationship between these indicators and the energy balance, dissipation, stability under perturbations, and the classical parameters of the flow must be established. ‘Efficiency’ must be defined by a measurable ratio between useful transport and energy cost.

Test criterion — In a facility with controlled helical flow, η , transverse dispersion, pressure, flow rate, dissipation, and stability are measured simultaneously; axialization is supported only if the proposed indicators predict a reproducible improvement over the standard parameters.

The Σ_{gd} transition regime is analyzed in the next chapter, together with genesis, systemic separation, and the first F.T.W. *Axialization is not the birth of the system, but the evolutionary limit of its stabilization. If Σ_{gd} denotes the proposed threshold for the loss of one state and the emergence of another, axialization describes the maturation of transport efficiency. The two regimes must be kept distinct.*

17.2. Definition of axialization in the Unified Theory

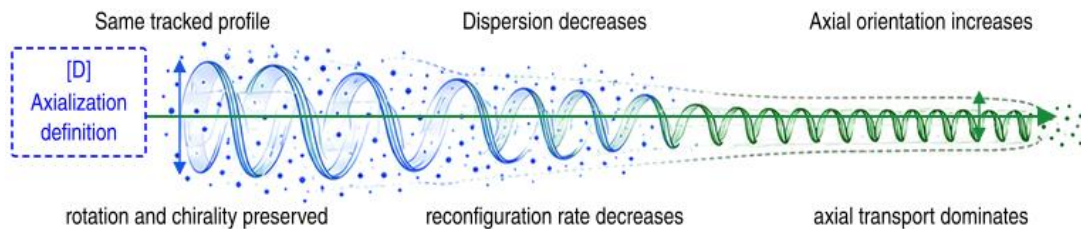
In the Unified Theory, axialization is the evolutionary process through which a coherent helical flow reduces its transverse dispersion and reconfiguration rate, while the ratio $\eta = v_a/v_t$ increases for the same tracked profile. It does not cancel rotation, eliminate chirality, or transform the helix into an inert line. The definition is kinematic and operational: it does not include the condition $C_c \rightarrow 0$ and must be evaluated through comparable observables.

An unaxialized flow may display large transverse components, oscillations, and local variations. An axialized flow has, by definition, a higher η and lower transverse dispersion, but the observed signal depends on the measured quantity and the detector. Capture, orientation, or long-range interactions do not result from axialization and must be treated as distinct hypotheses.

This definition must be connected to the extended state of the helical flow. A flow is defined not only by its visible form, but by the set of parameters that preserve its identity:

$$\mathcal{S}\chi_{ind} = (C_c, C_r, \eta, S, \chi, \varphi)$$

In this set, C_c describes flow-rate variation, C_r the rotational level, η the axial–tangential orientation, S the axial direction, χ the chirality, and φ the phase. Axialization occurs when η increases concurrently with reductions in transverse dispersion and in the reconfigurations required to preserve the state. The number α is calculated separately and does not define axialization.



Therefore, axialization may be defined as the stabilization limit of the $\mathcal{S}\chi$ state. At this limit, the flow remains helical, but its transverse expression becomes minimal relative to the axial transport function. The lateral component is not canceled, but disciplined. The whip does not disappear, but it no longer dominates. The arrow of transport becomes the principal expression of the mature system.

17.3. Idealization, conservation, and adaptation: the path toward axialization

Axialization does not occur at the beginning of a flow's existence. Before it come genesis, systemic separation, induction, instability, the search for form, selection, compatibilization, and adaptation. A flow is not born axialized. It becomes axialized if it succeeds in preserving sufficiently well what defines it. For this reason, the path toward axialization passes through three conceptual stages: idealization, conservation, and adaptation.

Idealization is the condition in which the flow becomes fundamentally analyzable. It does not mean that the real system is perfect, but that disorder does not immediately destroy the structure. Near the ideal regime, invariants may be formulated, stable relationships identified, and the identity of a flow discussed over durations longer than a local fluctuation. Without this approach to idealization, any flow is merely a turbulent event, not a coherent system.

Conservation is the stage in which the system tends to preserve the quantities that define its identity. In fluid mechanics, this may be read through vorticity, circulation, vorticity flux, and helicity. In the Unified Theory, the proposed level adds conservation of the Preda quantities over the coherent interval; α is then conserved algebraically and does not constitute an additional law. Conservation does not mean immobility, but constrained transformation.

On the basis of the principle formulated earlier—the geometry adapts to preserve the internal state, while failure of adaptation produces decoherence—axialization denotes the case in which successive reconfigurations converge toward increasingly stable transport.

Thus, axialization is the limiting effect of successful adaptation. It is not a geometry imposed from outside, but the result of internal selection. Of the possible forms, the one that hypothetically persists is that which preserves C_c and the rotational descriptor C_r , increases η and reduces transverse dispersion with minimal geometric stress. α follows from the Preda quantities and is not an independent condition of the process.

17.4. Axialization and the mobile scale of systems

The chapter on tree-like architecture introduced an essential idea: any system may be selected at a given scale, and the analysis may descend or ascend. If we descend, the system decomposes into filaments, clusters, and lower-scale flows. If we ascend, the same system becomes a constituent element of a higher-scale flow. Axialization must be understood within this logic of mobile scale.

At a small scale, axialization may be read as the stabilization of a constituent filament. At a larger scale, it may be read as the stabilization of a vortex tube. At an even larger scale, it may appear as the orientation of a bundle, a branch, a jet, or a cosmic filament. The principle is the same: the system reduces its unnecessary transverse components and orders its transport along a dominant functional axis.

This perspective avoids an important error. There is no single universal axialization valid for only one level of matter. There are axialization regimes at different scales. What is an axialized flow at one scale may become, at the higher scale, a constituent element of a larger flow, which may in turn become axialized. Thus, axialization is recursive. It may occur within a cluster, in the tube's filaments, in the tree's branches, or in cosmic structures.

This recursivity explains why nature can build similar structures at very different scales without repeating identical objects. It is not matter that repeats, but the principle: coherent transport seeks the axis. The axis is the direction in which the cost of adaptation falls, loss is reduced, memory is preserved, and the transport function stabilizes.

In this reading, axialization is not an absolute terminal stage. It is a local limit of efficiency for the scale under analysis. A system axialized at one scale may enter, as a constituent element, a new larger architecture, where it will be subjected to other demands, other polarizations, and other possibilities of axialization.

17.5. Axialization in relation to IN–transport–OUT

In every coherent open system, the Unified Theory uses the IN–transport–OUT architecture. This triad is not a graphic scheme, but a functional reading of the flow. IN represents capture, accumulation, and preparation; the transport region represents stabilization, transfer, and conservation; OUT represents discharge, redistribution, and branching. Axialization must be located in relation to this triad.

In its mature form, axialization belongs primarily to the transport region. There the system seeks maximum efficiency. In IN, flows are gathered, compressed, oriented, and prepared for continuity. In OUT, the flow is released, branched, and adapted to new domains. Between these two regions, transport itself needs stability, coherence, and minimal losses. There axialization becomes functional.

Nevertheless, traces of axialization may also be observed in the IN and OUT regions. In IN, dispersed flows may be forced to orient toward a common axis. This is a preparatory, incomplete, sometimes violent axialization associated with capture. In OUT, the flow may temporarily preserve axial memory before branching. This is a residual axialization that transmits direction, sense, and coherence to branches born from the trunk.

Nevertheless, axialization must not be confused with contraction of the IN roots or with OUT branching. Contraction may prepare the axis, but it is not yet efficient transport. Branching may preserve the axis, but redistribution has already begun. *Axialization proper is the regime in which the system transports with minimal reconfiguration, after being loaded and before being discharged.*

This distinction will be important in the next chapter. The Σ_{gd} regime is hypothetically associated with thresholds of genesis, capture, or reconfiguration—that is, moments when the system is born or reconstructed. Axialization is not that threshold. It is the stable, mature, efficient part of the path between two thresholds.

17.6. Reduction of the transverse component and the filamentary regime

Helical flow always has two inseparable kinematic dimensions: axial transport and transverse rotation. Without axial transport, there is no coherent directional transfer. Without transverse rotation, there is no helix, chirality, or flow memory. Axialization does not eliminate this dual nature. It changes the ratio between the two components.

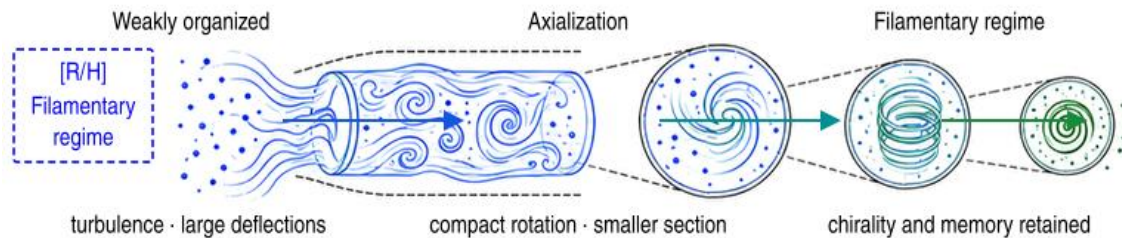
In a weakly organized flow, the transverse component may visibly dominate. The tube wavers, widens, fragments, produces turbulence, unstable layers, and large deflections. In an axialized flow, the transverse component is preserved as an internal mechanism of coherence, but it no longer produces great external disorder. Rotation remains inscribed in the flow structure, yet its lateral manifestation becomes fine, compact, and difficult to separate from axial transport.

To describe this tendency, we may use the kinematic ratio between the axial and tangential components:

$$\eta = v_a / v_t$$

where v_a represents the axial component of transport, while v_t represents the tangential component. The ratio must not be confused with C_e : C_e remains the rotational/cyclic descriptor measured through frequency, while η measures the kinematic orientation of transport. Axialization requires an increase in η for the same tracked profile, together with reductions in transverse dispersion and in the reconfiguration rate. It does not automatically imply $C_e \rightarrow 0$ or the invisibility of the flow.

When this tendency intensifies, what may be called the filamentary regime appears. A filament is not a line without structure. It is an extremely concentrated helical flow in which the apparent cross-section decreases, the lateral signature is reduced, and transport becomes difficult to observe directly. The filament is the form in which the helix preserves its chirality and memory while minimizing its transverse footprint.



In this sense, the filamentary regime denotes axialization with a high η and reduced transverse dispersion. It may produce a smaller transverse signal that is difficult to observe, but detectability must be calculated separately for each detector. Cosmological analogies remain speculative until there is a differential prediction.

17.7. Coherent stability: when form no longer seeks another form

The stability of a helical flow does not mean freezing its form. A perfectly rigid system could not respond to the environment and would break at the first incompatible demand. Coherent stability is something else: the flow's capacity to adapt little enough to remain the same and much enough not to be destroyed. Axialization occurs when this balance becomes highly efficient.

In an unaxialized state, the system is still seeking the ideal form of transport. It changes directions, tests couplings, emits or absorbs roots/branches, partially couples/decouples, reorients itself, and redistributes its internal components. This search is necessary during phases of genesis, growth, branching, or polarization. But as the flow matures its own constants, the need for reconfiguration decreases.

Axialization is the moment when a form no longer seeks another form in order to transport. Not because it can no longer evolve, but because it has found a local geometry of minimum tension. C_e and C_r can be preserved with minor adjustments, while η indicates the predominance of axial transport. Interaction compatibility remains a separate issue, in which the role of α is still hypothetical.

This stability is selective in character. An axialized flow does not become compatible with everything. On the contrary, precisely because it has a well-stabilized state, it becomes more demanding with respect to couplings. Compatible interactions may be transmitted with high efficiency, whereas incompatible interactions may be rejected, deflected, or may produce local stress. *Thus, axialization increases stability, but may also increase sensitivity to specific incompatibilities.*

In a tree, the model allows an axialized trunk to transmit toward roots and branches. The roles of field line or cosmic filament are correspondence hypotheses and do not follow from η . For each scale, the propagation mechanism, the observation, and the prediction that distinguishes the model from standard theory must be specified.

17.8. Indirect detection of axialized flows

If an experiment shows that axialization reduces a defined transverse signature, the flow must be tracked both directly and through quantified secondary effects. The method requires comparing the signal with noise and with the predictions of standard mechanisms; the absence of a direct image is not confirmation.

A turbulent flow may produce large signals through agitation, dissipation, and instability. An axialized flow may produce smaller transverse signals, but the orientation of other flows, stabilization of branches, polarization, or a change in coupling probability are additional effects that must be modeled and measured separately.

Detection of axialization must combine measurement of η and transverse dispersion with quantified secondary effects. Orientation, correlations, or action at a distance are not in themselves evidence of a filamentary channel; the hypothesis becomes testable only if it produces a precise departure from electromagnetism, gravity, or fluid mechanics.

The hypothesis must be maintained with caution. A weakly detectable phenomenon does not prove an axialized flow or an invisible filament. The search for a coherent support is legitimate only if the model defines the expected signal and distinguishes it quantitatively from magnetism, gravity, and other established explanations.

In this sense, the axialized flow is closer to an infrastructure than to an object. It resembles a transport path that is seen not through itself, but through what it enables: delivery, orientation, correlation, capture, discharge, or reconfiguration. Where systems behave as though linked through a common architecture, but the link does not appear as a solid object, axialization offers a possible geometrodynamical reading.

17.9. Axialization, superfluidity, and dark transport

A speculative extension links axialization to transport with a reduced direct signature. Even if transverse dispersion and local dissipation decrease, undetectability does not follow automatically. The hypothesis requires a finite observation and an experiment that distinguishes the proposed transport from the absence of a signal.

The axialized regime may be compared by analogy with low-dissipation transport, but it is not superfluidity by definition. Superfluidity involves a quantum order parameter, specific effective viscosity, and quantized vortices; axialization must separately show whether it reproduces any of these properties.

From this, the dark-transport hypothesis may be formulated: an axialized regime might have a reduced transverse footprint and indirect effects. The hypothesis does not yet explain dark matter or a known interaction; it must specify what measurable effect it produces in addition to standard models.

This hypothesis is not a demonstration concerning dark matter. It remains a theoretical opening that must be expressed through a differential prediction: the indirect observable, the magnitude of the effect, the uncertainty, and the result that would reject the association with axialization.

The term ‘dark transport’ denotes only the hypothesis of a reduced transverse signature. The absence of a signal does not confirm the existence of the structure; a positive observation, an amplitude estimate, and a result that would falsify the model are required.

17.10. The limit of axialization and the vicinity of decoherence

Axialization is the limit of efficiency, but no limit is infinite. An axialized system may remain coherent as long as the environment does not force it out of the conservation domain of its state. If demands increase, if a node imposes an incompatible polarization, if the branch enters a region of geometric stress, or if an interaction alters the internal ratios too greatly, even an axialized flow may reach decoherence.

A fine distinction must be maintained here. *Axialization is a success of adaptation, but success does not guarantee eternity. On the contrary, the more stabilized a state is, the more dependent it may be on the conditions that support its stabilization.* A brutal change in these conditions may break compatibility. A system that transported very efficiently may reach a point where it can no longer adapt its geometry without losing its identity.

Decoherence does not occur because axialization is wrong. It occurs when the environment demands an adaptation that the axialized state can no longer provide without changing the independent components. At that moment, the flow can no longer preserve simultaneously C_c , C_r , η , direction, chirality, and phase within the coherent domain. The change in α is a consequence, not an independent criterion.

This situation prepares the chapter on the Σ_{gd} regime. But axialization must not be confused with Σ_{gd} . It may precede a crisis, be driven toward a critical limit, or enter the vicinity of a reconfiguration, yet it is not itself genesis. *Genesis begins where the old state can no longer continue and where a new systemic separation becomes possible.*

Therefore, axialization describes the upper limit of a coherent life of transport. Decoherence describes the loss of this life. The Σ_{gd} regime, as it will be addressed below, describes the threshold through which the death of one state may become the birth of another.

17.11. Fundamental principle — axialization

Axialization is formulated as a fundamental principle of the proposed framework: a coherent helical flow may evolve toward a regime in which the ratio $\eta = v_a/v_t$ increases, while transverse dispersion and the rate of reconfigurations decrease. The energy balance and the declared observables must confirm that this evolution corresponds to more efficient transport.

The formulation does not state that all flows reach axialization and does not define it through $C_c \rightarrow 0$. Some flows disintegrate, remain turbulent, branch, or are absorbed before this regime. A reduced transverse signature does not automatically imply invisibility; detectability requires a positive observation and a separate prediction.

Axialization may be interpreted as selection through efficiency only in the geometrodynamic sense: configurations that reduce stress and preserve the state within their coherence domain persist. The analogy with Darwinism does not prove replication or heredity and must remain distinct from biological selection.

The axialized regime remains finite and condition-dependent. When the environment imposes an adaptation incompatible with the conserved state, the system may proceed toward decoherence and reconfiguration. This chapter examines the threshold without equating axialization with Σ_{gd} or genesis.

PART IV · TRANSITIONS, MASS, AND VERIFICATION

18. The geometrodynamic transition regime Σ_{gd} — genesis, systemic separation, and the first E.F.T.

18.1. Why must Σ_{gd} be separated from axialization?

The preceding chapter separated axialization from the geometrodynamic transition regime Σ_{gd} . Axialization represents the maturation of a coherent flow: the reduction of losses, stabilization of parameters, increased transport efficiency, and increasingly strong axial orientation. It belongs to evolution and efficiency; Σ_{gd} denotes the hypothesis of the threshold between the loss of one state and the stabilization of another.

This distinction avoids an important confusion. An axialized flow does not enter the Σ_{gd} regime merely by virtue of axialization. It may be efficient and stable, but reduced detectability does not follow automatically. Axialization shows that the system may preserve C_c , C_r , η , direction, chirality, and phase within the coherent domain; α remains a derived ratio, not an additional condition.

The Σ_{gd} regime is postulated where the old state can no longer be preserved through ordinary adaptation and the new state has not yet stabilized. It is neither a fifth kernel nor an ordinary interaction, but a critical interval between two state domains: the loss of one coherence and the possibility of stabilizing another.

Therefore, axialization and Σ_{gd} are limits of different natures. Axialization is the efficiency limit of a flow that remains within the same state domain. Σ_{gd} is the hypothetical identity threshold of a flow that can no longer remain the same. The former describes maturity; the latter describes loss of coherence, reconfiguration, and the possible stabilization of a new state.

18.2. Systemic separation — the first act of genesis

Every analysis begins by delimiting a system from a vast domain called space. This idea was established at the very beginning of the volume: before any measurement, before any equation, and before any interpretation, there must be a domain that can be called a system. Without delimitation there is no interior and exterior; without interior and exterior there is no exchange; and without exchange there is no analyzable transport.

In this chapter, the same idea is taken further. Systemic separation is not merely the act of the researcher who draws a conceptual boundary. It must have a physical counterpart: the emergence of a region of coherence in an environment that, before this emergence, could not be treated as a distinct system.

Genesis begins when a flow becomes functionally separated from the background out of which it emerges.

The first systemic separation is the moment when four elements are born simultaneously: an interior, an exterior, a boundary of exchange, and a direction of transport. Before this moment, we cannot rigorously speak of an individual flow, state identity, or memory. We may speak only of an environment, a potential difference, an instability, or a possibility. After separation, the system appears: a flow with an axis, direction, chirality, input, path, and output.

In the Unified Theory, the separation between interior and exterior is the proposed operational definition of genesis. This conceptual choice neither eliminates nor replaces the cosmological model of the early state of the Universe or the singularity theorems. It states only that a system becomes analyzable when an organized difference capable of supporting coherent transport emerges.

18.3. The first E.F.T. — the minimal form of separated transfer

The Fundamental Transfer Helix, E.F.T., must be understood here as the minimal form through which systemic separation becomes transport. It is not merely a line, merely a drawn helix, or merely a metaphor for flow. The first E.F.T. is the first regime in which a difference of state organizes into a geometry capable of transferring something: mass, momentum, angular momentum, geometrodynamical information, or a combination of these.

If the system is the delimitation, E.F.T. is the dynamics of this delimitation. It turns separation into process. Through E.F.T. emerge the axis, flow direction, chirality, rotation, path, and the possibility of preserving internal ratios. This minimal form already contains the seeds of all subsequent structures: the vortex tube, cluster, node, tree, kinematic correlation, and axialization.

The first E.F.T. must not be regarded as a static object. *It is a flow of genesis. It does not transport because it already exists as a mature tube; rather, it becomes a tube because transport begins to organize. Within it is born the first functional difference among IN, path, and OUT. IN captures, the path organizes, OUT discharges. This triptych is not added later; it is the minimal structure of any geometrodynamical transfer.*

For this reason, the first E.F.T. may also be called the first dynamic separation of the system. It is the moment when the background becomes flow, the flow becomes system, and the system becomes analyzable. *In this sense, the geometrodynamical transition regime Σ_{gd} is not a point without geometry, but the threshold at which the first transfer geometry separates from the environment that contains it.*

18.4. Σ_{gd} as a transition interval toward genesis

In current physics, the term singularity denotes different technical situations: the irregularity of a solution, geodesic incompleteness, or the divergence of quantities. In quantum theories, divergences may signal the limit of a parametrization or the need for renormalization. The proposed framework does

not solve these problems through reinterpretation; it separately tests whether finite transition dynamics, denoted Σ_{gd} , can add predictive power within a well-defined domain.

Current physics — A mathematical singularity is an irregularity of the solution; in general relativity, the robust criterion is geodesic incompleteness, while curvature divergence is a possible signal. A phase transition, vortex reconnection, and the genesis of a tornado are distinct phenomena.

Theory proposal — Σ_{gd} denotes a *geometrodynamic transition regime* between two coherent states. The notation does not claim to resolve relativistic singularities and does not automatically turn every transition into a gravitational phenomenon.

Missing bridge — The dynamics of Σ_{gd} , the finite observables, duration, entry/exit conditions, and relationship with the equations of the domain under study must be defined. For black holes, a covariant solution compatible with Einstein's equations and observations would be required.

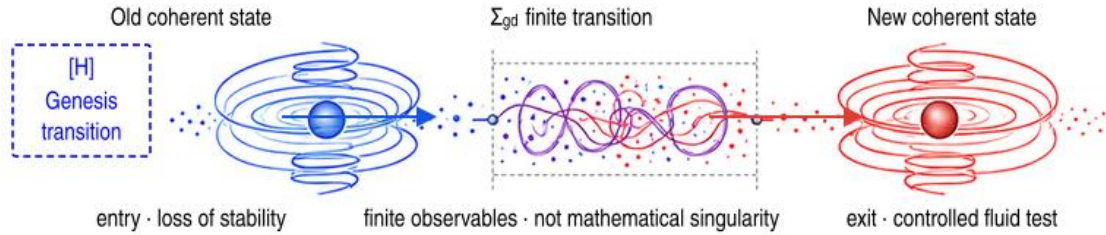
[F] Test criterion — The first verification must be performed in a controlled fluid transition: the loss of stability of the old state, the transition interval, and the emergence of the new state are measured, then compared with bifurcation theory and standard fluid mechanics.

*In the proposed framework, Σ_{gd} is a critical interval between two coherent states. It must be explicitly called a *geometrodynamic transition regime* so that it is not confused with a mathematical singularity, geodesic incompleteness, or a curvature divergence.*

This transition may be conceptually expressed as follows:

$$\mathcal{S}\chi(\text{old}) \rightarrow \Sigma_{gd} \rightarrow \mathcal{S}\chi(\text{new})$$

where $\mathcal{S}\chi$ denotes the extended state of the flow, while Σ_{gd} denotes the proposed geometrodynamic transition regime. The old and new states each have an independent vector ($C_c, C_r, \eta, S, \chi, \varphi$). A critical interval is postulated between them, in which the former identity cannot be maintained and the latter has not yet formed; this is not a demonstrated mathematical singularity.



This formulation assigns the Σ_{gd} regime a finite geometrodynamic duration. It is not the abstract instant at which mathematics breaks down, but the critical interval between two coherent states. Structurally, Σ_{gd} is a gateway; evolutionarily, it describes the loss of identity of one state and the possibility of stabilizing another. Its duration, observables, and law of evolution remain to be determined experimentally.

18.5. The critical condition: when adaptation can no longer preserve identity

A coherent helical flow preserves its identity through adaptation. It changes its radius, pitch, torsion, curvatures, branching, and internal ratios in order to preserve the fundamental constants simultaneously. This is the mechanism through which the system remains the same even though its geometry changes.

The geometrodynamic transition regime Σ_{gd} is postulated when adaptation is no longer sufficient and the imposed stress exceeds the flow's capacity to preserve its state. The system can no longer simultaneously maintain transport variation, the rotational/cyclic component, and the axial–tangential ratio within the model's tolerance.

The internal state relation remains the conceptual reference:

$$\alpha = \frac{C_e \cdot C_f}{C_c^2}$$

When one of the independent components leaves the coherent domain, α may change or diverge if C_c approaches zero. This behavior is only a diagnostic of the parametrization. It neither demonstrates a physical singularity nor decides the transition; the proposed criterion remains the impossibility of preserving the independent vector through the permitted dynamics.

[D] *The proposed criterion for entry into Σ_{gd} is the departure of the independent vector from the stability domain of the old state, followed by the reproducible formation of another state domain. The*

statement must be evaluated through a stability analysis and is not equivalent to the appearance of a singularity in the sense of mathematical physics.

18.6. Genesis through an attractor and genesis through induction

The birth of a flow does not have a single form. In the theory developed thus far, two principal situations can be distinguished: genesis through an attractor and genesis through induction. Both may lead to the emergence of an E.F.T., but their logic differs.

In genesis through an attractor, the flow arises through a potential difference that captures, concentrates, and orients the environment. The attractor is not a magical point, but a region of deficit or difference that compels matter, energy, or local flows to organize toward an axis. Here the tendency toward convergence appears first. The medium is attracted, compacted, rotated, and channeled. If the process becomes coherent, an axial flow with direction, chirality, and a transport function is born.

In genesis through induction, the flow does not begin directly from a center of capture. It may arise through the action of a neighboring flow, through shear, marginal contact, a velocity difference, or torsion transfer. An existing flow may induce another flow in the neighboring medium; this is genesis through proximity, whose dynamics must be specified.

The kernel C–A describes the induction of genesis in relation to an attractor, but Σ_{gd} is not reducible to C–A. The kernel is the interaction mechanism; Σ_{gd} is the state-threshold hypothesis. C–A may initiate, M–C may continue axially, C–C may replicate laterally, and T–C may convert perpendicularly; entry into Σ_{gd} must be decided by the measurable departure from the stability domain of the old state.

Therefore, genesis must not be confused with a single event. It is a family of processes through which a flow separates, orients itself, and acquires identity. Σ_{gd} denotes only the postulated critical interval of this separation.

18.7. The tornado — the fluid analogue of the genesis of a vortex

To illustrate the genesis of a vortex state without excessive abstraction, the fluid analogue of the tornado may be used. A single tornado is not yet a tree, network, or set of distributed branches; it is a primary flow that has acquired an axis, direction, and chirality. The analogy does not turn it into a physical singularity.

In a tornado, the environment is no longer uniform. A privileged direction, convergence, rotation, and a central transport region have appeared. From that moment, the system may be analyzed as an entity: it has an interior and exterior, an input and output, a kinematic boundary, and a ratio between rotation and axial transport. This is why a tornado may serve as a natural image of the first E.F.T.

As established in the preceding volume, a natural tornado is inductive, generated by rising convection currents. In the laboratory, it can also be produced by a sink, or attractor.

The tornado is not, however, the end of evolution. It is only the beginning. If it stabilizes its parameters, it may become a mature vortex tube. If it interacts with other flows, it may produce roots and branches, bundles, nodes, or clusters. If it fragments, it may generate secondary flows. If it enters extreme geometric stress, it may lose coherence and reconfigure into another state.

In this sense, the tornado is a fluid analogue of the genesis of a vortex state, not a physical singularity. Its formation may be analyzed through instability, convection, shear, vorticity, and bifurcations; the geometrodynamical model must add a measurable prediction to these mechanisms.

18.8. Black holes — the limit of the capture-and-reconfiguration analogy

In current physics, a black hole is defined through the geometry of spacetime and the event horizon. In the Unified Theory, it may be discussed only as a possible speculative application of Σ_{gd} . Capture—namely genesis through a sink—and reconfiguration cannot be deduced from the vortex analogy; they must be formulated covariantly and compared with geodesics, black-hole thermodynamics, and astrophysical signals.

The event horizon may be interpreted as a radical systemic boundary, viewed as an attractor. It generates the separation of exterior from interior in a manner irreversible for the external observer.

Beyond this boundary, flows can no longer be described through the same state ratios as before. Light, matter, and information do not cease to exist as reality, but lose their former form of accessibility.

In this speculative reading, the black hole is treated as a regime of extreme transformation. Nevertheless, the loss of accessibility of the old state does not demonstrate the existence of Σ_{gd} . Such an application requires a covariant definition of the observed elements, compatibility with Einstein's equations, and predictions distinct from general relativity.

The hypothesis does not require the interior of the black hole to be described as an infinite physical point. It proposes only the investigation of a possible regime of capture through an attractor, decoherence with respect to the preceding state, and reconfiguration. Without explicit relativistic dynamics, this reading remains an analogy and not a model of a black hole's interior. Moreover, this hypothesis is not limited to the size of the black hole, predicting that the principles extend across every scale.

Thus, the black hole remains a limiting application of the hypothesis: a possible threshold of transformation, not a cosmic confirmation of Σ_{gd} . Validation would require an observable deviation not predicted by general relativity.

18.9. The death of one state and a new birth

In the Unified Theory, death is not the absolute cancellation of a process. It is the loss of coherence that allowed a structure to remain identifiable. A vortex tube may die as a tube, while its vorticity, mass, energy, and geometrodynamical information continue in other forms. A cluster may become decoherent, while its elements join other flows. A tree may lose global coherence, while its branches, nodes, or marginal fields become constituent material for other systems.

The loss of one state may therefore precede the stabilization of another. This is the evolutionary idea that links Σ_{gd} with geometrodynamical selection through stability. The form that can preserve its relevant invariants persists; when this is no longer possible, the old form ends, and a new identity emerges only if the environment permits another coherent organization.

Σ_{gd} denotes precisely this postulated transition zone. It belongs fully neither to the old system nor to the new one: it is the interval in which what had been stable becomes unstable and a new configuration begins to acquire system properties.

At a small scale, this may be read as reconnection, fragmentation, emission, absorption, or reconfiguration of clusters. At a large scale, it may be read as stellar death, collapse, the birth of a jet, disk formation, a black hole, or cosmic reorganization. At every scale, the principle is the same: a coherent state has a finite duration, and its limit may become the genesis of another state.

18.10. Transition, scale, and recursivity

The preceding chapters showed that the system may be chosen at any scale. We may descend toward smaller structures or ascend toward larger structures. At each level, what appears as a local object may be the result of lower-level flows and a constituent element of higher-level flows. This recursive logic requires the domain and observables of Σ_{gd} to be declared separately at each scale.

Σ_{gd} is not postulated as a single and absolute event, but as a type of system-dependent threshold. The birth of a vortex, formation of a cluster, reconnection of a flow network, and collapse of a stellar structure are distinct physical phenomena; they may be compared only through normalized observables and must not be declared manifestations of the same mechanism before testing.

This formulation makes the hypothesis usable only if Σ_{gd} is assigned observables, a duration, and entry and exit conditions. Encountering an infinity, divergence, or discontinuity does not prove that the model lacks a physical state; the legitimate question is whether well-defined transition dynamics eliminate the problem and produce testable predictions.

At a recursive scale, each Σ_{gd} regime must be related to the system under analysis. For the old state, it is a stability limit; for the new state, a possible zone of genesis; for the observer, the interval in which the old descriptors are no longer sufficient and other measurable parameters must be introduced.

18.11. Conclusion — Σ_{gd} as the proposed threshold of genesis

The geometrodynamic transition regime Σ_{gd} is postulated as the threshold between the loss of stability of one state and the stabilization of another. It may be the end of the old description and the beginning of the new one without being automatically identified with a singularity, whether mathematical or gravitational.

The first E.F.T. offers the minimal image of this process. It is systemic separation transformed into transport: the emergence of an axis, direction, chirality, IN–path–OUT regions, and the possibility of preserving an identity. Before it there is only background, gradient, or instability. After it there is a system.

Through this interpretation, black holes, tornadoes, vortex reconnections, state collapses, and geneses at different scales may be compared only as transitions between coherence regimes, without being declared identical phenomena. Axialization describes the maturation of coherent transport; Σ_{gd} denotes the hypothesis of the interval in which the old state domain is lost and a new domain may emerge.

Thus, the Unified Theory describes a succession of flows that separate, stabilize, become axialized, lose coherence, and reconfigure. Σ_{gd} is the proposed name for the threshold between two state domains; it is not identified with a mathematical or relativistic singularity and becomes a physical concept only through a measurable transition criterion.

Logical synthesis of Chapter 18

Consequence — systemic separation

A system becomes analyzable only after a functional separation between interior and exterior emerges. The first geometrodynamic separation is the beginning of genesis.

Hypothesis — the first E.F.T.

The Fundamental Transfer Helix is the minimal form through which systemic separation becomes organized transport, with an axis, direction, chirality, and IN–path–OUT regions.

Hypothesis — the geometrodynamic transition regime Σ_{gd}

Σ_{gd} is neither a kernel nor a mathematical singularity; it is the postulated critical interval in which the old state loses stability and the new state has not yet stabilized.

Conceptual consequence — reconfiguration after loss of coherence

The decoherence of a state does not cancel the process, but releases matter, energy, and geometrodynamic information for subsequent reconfigurations.

Genesis is placed here not because it appears late in the existence of the system, but because only after evolution, polarization, branching, correlation, and axialization have been described can what is actually born be truly understood. Genesis is not the mere appearance of an object, but the emergence of a systemic separation capable of supporting flow, memory, and evolution.

The beginning of any Universe may be observed first, but can be understood only at the end.

19. Space–Time–Cycle — the geometry of becoming in recursive systems

19.1. Why the concept returns here

The concept of space–time–cycle was introduced at the very beginning of the volume, where the system was defined as an open domain of analysis, delimited by an interior, an exterior, and a boundary of exchange. At that point, the cycle appeared as a methodological necessity: space describes the system's geometry through delimitation, time describes the succession of transformations, and cycle describes the system's position in its own becoming.

Nevertheless, at the beginning of the work this idea could not yet be understood in its full force. The reader did not yet have at hand the vortex tube, invariants, the Preda constants, interaction kernels, geometrodynamical memory, geometrodynamical Darwinism, flow taxonomy, conglomerate polarization, tree-like architecture, kinematic correlation, axialization, and the Σ_{gd} regime as a threshold of genesis. Without these stages, the cycle risked being read as mere repetition.

Now, after the description of genesis, evolution, stabilization, axialization, and the limit of decoherence, the concept can be formulated in mature form. A cycle is not a circle. It is not the identical return of a process to the same place and at the same time. *The cycle is the internal history of a system that repeats functionally but changes structurally. It is recurrence with accumulation, return with displacement, memory with transformation.*

Therefore, the present chapter does not repeat the introduction of the concept. It places it in its final position: as the third conceptual coordinate required to describe recursive systems. If the Σ_{gd} regime showed how a flow is born, space–time–cycle shows how that flow becomes, exhausts its possibilities, and may prepare a new birth.

19.2. The limit of the space–time description for systems with their own history

Space provides location and geometry, while time provides succession and duration. For a geometrodynamical system, however, these are not sufficient: as established in Chapter 2, the state also depends on the transformations already undergone.

Current physics — The state of a system may include internal variables, order parameters, phases, and history variables without automatically adding a new spacetime dimension. Proper time and global time remain distinct relativistic concepts.

Theory proposal — Cy is a normalized internal coordinate of a state's progress through genesis, stabilization, limit, and reconfiguration; T_{gd} measures internal geometric change, not the passage of physical time.

Missing bridge — The domain, normalization, the observables from which Cy is reconstructed, the equation dCy/dt , and the manner in which the stages are detected objectively must be defined.

[F] Test criterion — Cy is physically useful only if, when estimated from part of the data, it predicts the subsequent transition or response better than external time and the instantaneous state vector taken alone.

Two systems may have similar geometries and be observed during the same chronological interval, yet belong to completely different evolutionary states. One may be at genesis, another at maturation, another at axialization, another at the limit of decoherence. External time may place them on the same chronological line, but by itself it cannot say which internal stage each occupies.

This limit becomes even clearer in the recursive architecture of the Universe. A cluster may be the result of lower-level flows and simultaneously a constituent element of a higher-level flow. At one scale it appears as a localized object; at another it becomes flow material. Space may locate it, time may order its transformations, but cycle shows its position in the sequence genesis–stabilization–transport–limit–reconfiguration.

In this sense, space and time describe the framework of observation, while cycle describes the framework of becoming. Without cycle, the system risks being photographed rather than understood. Without cycle, flow becomes a trajectory but not a geometrodynamical life. Without cycle, the death of one state cannot be coherently linked to the emergence of another.

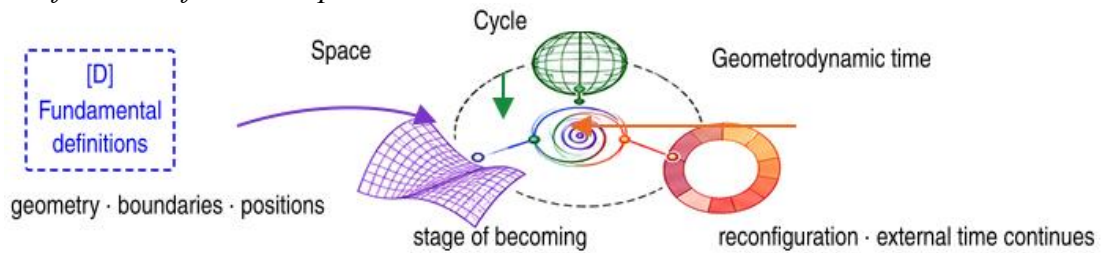
19.3. Fundamental definitions

In the Unified Theory, the three concepts must be clearly separated without being opposed to one another.

Within this framework, ‘space’ denotes the geometry of the analyzed domain: distributions, boundaries, relative positions, lengths, radii, cross-sections, branches, and stratifications. This is a methodological choice for describing the system, not a redefinition of relativistic spacetime.

The geometrodynamical time T_{gd} is an internal parameter that quantifies the change in geometry between states. The condition $T_{gd} = 0$ means only the absence of detectable reconfiguration for the

chosen resolution and interval; external physical time and proper time do not stop. T_{gd} is an internal descriptor of the transformation process.



Cycle is the system's position in its own history of genesis, adaptation, conservation, axialization, limit, decoherence, and reconfiguration. It does not replace time, but complements it. Time says when the transformation occurs; cycle says which stage of becoming is occupied by the system being transformed.

We may conceptually denote the evolutionary state of a system by the triplet:

$$\text{STC} = (\mathbf{G}, T_{gd}, \text{Cy})$$

where $\mathbf{G}$ represents the geometry of the system, T_{gd} represents geometrodynamical time, while Cy represents the internal cycle of the process. This notation is not a definitive equation, but a rule for organizing the description. It requires the analysis not to confuse form, duration, and the internal phase of existence.

19.4. The short cycle and the long cycle

A natural system does not undergo a single simple cycle. It consists of many short cycles integrated into a long cycle. Short cycles maintain the local function. The long cycle describes the system's entire existence.

In a helical flow, short cycles may be local rotations, phase oscillations, reorientations of lateral whips, cyclic adaptations of the radius, repeated adjustments of the helical pitch, frequent couplings and decouplings, exchanges among twist, writhe, and linking, or local stabilizations of constituent filaments. They do not represent the complete life of the system, but sustain it continuously and even periodically.

The long cycle is the complete succession of the flow: systemic separation, genesis, stabilization, interaction, polarization, branching, transport, axialization, limit, decoherence, and possible reconfiguration. It cannot be understood through a single rotation, just as the life of an organism cannot be reduced to a single breath.

Therefore, short cycles are constituent processes. The long cycle is the history of the system. Short cycles repeat, but each repetition slightly modifies the system. The long cycle is built precisely from this accumulation. For this reason, in the Unified Theory, the cycle is not a perfect return, but a helical return: each recurrence occurs within an already modified system.

Conceptually, this relationship may be expressed as follows:

$$\text{Cy}_i = \mathbf{N} (\sum_k \mathbf{w}_k \text{Cy}_s, \mathbf{k} + \Delta \mathbf{G}^*),$$

with dimensionless terms and normalization $\mathbf{N}$.

The long cycle is constructed from weighted short cycles and from the dimensionless geometric variation $\Delta \mathbf{G}^*$. The operator $\mathbf{N}$ brings the result into the chosen domain; a cycle count is not directly added to a dimensional geometric quantity.

19.5. Helical repetition and the arrow of time

The usual image of a cycle is a circle. For the Unified Theory, this image is insufficient. The circle suggests a return to the same point. Nature does not function this way. A system never returns to exactly the same space, at exactly the same time, and in exactly the same internal state.

The correct representation of the natural cycle is the helicoid. The helicoid contains return, but also advance. It contains rotation, but also axial displacement. It contains recurrence, but also the arrow of time. This form better expresses the reality of geometrodynamical systems: they repeat processes, but do not return to their initial identity.

A flow may repeat the same transport function, but through each repetition it slightly modifies its geometry, stress distribution, memory state, and position within its own cycle. An organism breathes countless times, but does not remain the same organism. A river flows continuously, but rewrites its bed. A star pulses, but consumes its fuel. A vortex tube preserves its parameters, but may redistribute its helicity.

In this sense, the arrow of time is not merely an external thermodynamic fact. It is inscribed in the geometry of repetition. Every natural cycle produces a difference between what the system was and what it becomes. This difference is precisely the sign of geometrodynamical time.

19.6. Mobile scale and the recursivity of becoming

The chapter on tree-like architecture showed that we may choose a system at any scale. If we descend below that scale, we discover flows, filaments, clusters, and constituent structures. If we ascend above it, the chosen system becomes an element of a larger flow, a node in a network, or a branch of a global tree.

This perspective profoundly changes the idea of cycle. There is no single absolute cycle of the Universe, but cycles embedded within other cycles. The cycle of a cluster may be integrated into the cycle of a flow. The cycle of a flow may be integrated into the cycle of a node. The cycle of a node may be integrated into the cycle of a tree. The cycle of a tree may be integrated into a larger-scale cosmic network.

At each scale, the system has its own genesis, stabilization, transport regime, limit, and reconfiguration. But these cycles are not isolated. They influence one another. A local decoherence may modify a branch. A branch reconfiguration may modify the node. A change in the node may redistribute the tree. A global reorganization may impose new conditions on all constituent clusters.

Therefore, space–time–cycle must be understood recursively. What is a long cycle at one scale may become a short cycle for a higher scale. What is a local event for a tree may be the entire geometrodynamical life of a cluster. *This relativity of scale does not weaken the theory, but makes it coherent with the recursive structure of the Universe.*

The consequence of mobile scale may be formulated as follows:

A system is simultaneously the result of lower-scale cycles and a constituent element of higher-scale cycles.

19.7. Cycle as the internal state position of the helical-flow process

To become useful, cycle must be treated as a state variable of the process, not as a metaphor. A flow is defined not only by where it is and by the instantaneous values of its parameters, but also by the internal stage in which those parameters are situated.

The same value of a constant may have a different meaning at different stages of the cycle. At genesis, a value may indicate the formation of a state. During maturation, the same value may indicate stability. At the limit, it may indicate rigidification. Before decoherence, it may indicate the impossibility of adaptation. Therefore, the value must not be read in isolation from the evolutionary phase.

In the Unified Theory, the cycle may be read as an internal phase of the system. This phase may be conceptually expressed in stages:

$$C_y \in [0, 1);$$

the subintervals are defined by observable thresholds of the state vector, not merely by narrative labels.

Stage labels are interpretations of C_y intervals and must be tied to measurable thresholds: the emergence of a state, parameter stability, increase of η , loss of stability, and formation of a new state. Not all systems need to pass through the same subintervals.

Without this variable, two flows with similar geometries may be confused, even though one is at the beginning of stabilization and the other at the limit of decoherence. The cycle is what allows these cases to be separated. It is the internal coordinate of maturity, tension, and the possibility of transformation.

19.8. Space, time, and cycle in the vortex tube

The vortex tube is the minimal example in which the three coordinates may be understood together. The tube's space is its geometry: axis, radius, cross-section, helical pitch, curvatures, branches, layers, constituent filaments, and topological relationships. Geometrodynamical time is the successive transformation of this geometry: thinning, thickening, elongation, twisting, reorientation, branching, reconnection, or axialization. *Cycle is the tube's position within its own life as a flow.*

At genesis, the tube is not yet stable. It emerges through systemic separation and initiation of the first E.F.T. During stabilization, the tube attempts to preserve flux and the rotational/cyclic component, while η describes the orientation of transport. During interaction, it hypothetically couples through kernels; polarization and tree-like architecture then emerge. During axialization, η increases and transverse dispersion decreases. If adaptation can no longer preserve identity, decoherence occurs.

This succession cannot be described sufficiently through instantaneous geometry. Nor is external time sufficient. The tube's cyclic position is required. Only through it can we say whether a flow is young, mature, axialized, stressed, unstable, or prepared for reconfiguration.

19.9. Memory, information, and cycle

Cycle is inseparable from memory. A system may pass through a cycle only if it preserves something of its own identity between stages. If everything were lost at each transformation, we would no longer speak of a cycle, but of independent appearances. *Memory enables continuity to be recognized.*

In the preceding chapters, geometrodynamical memory was linked to the Preda constants and their values. ***The constants provide the support of memory, while their values provide the particular information.*** *Cycle is the way this memory crosses transformation. It shows whether the system succeeds in preserving what must be conserved while changing its form.*

Therefore, cycle is not merely a succession of phases. It is a process of reading, preserving, and rewriting memory. In the IN region, the system receives matter, energy, and geometrodynamical information. In the transport region, it organizes them. In the OUT region, it transmits them. At each passage, memory may be preserved, redistributed, or lost. If it is lost beyond the permitted limit, the system no longer continues the same cycle; it enters a regime of decoherence and reconfiguration.

Thus, cycle is the link between memory and evolution. Memory without cycle would be inert conservation. Cycle without memory would be succession without identity. Together, they define the geometrodynamical existence of the system.

19.10. Geometrodynamical death and new birth

In the language of the theory, the death of a system is not the absolute disappearance of matter, energy, or information. It is the loss of coherence that allowed the whole to remain the same system. What dies is the old geometrodynamical identity. What remains may become material for other processes.

This idea closes the connection between the Σ_{gd} regime and cycle. The Σ_{gd} regime is the threshold at which the old coherence can no longer continue and a new coherence has not yet stabilized. In relation to the old system, it is an end. In relation to the new system, it is genesis. In relation to the cycle, it is the passage between two geometrodynamical lives.

From this follows one of the most important formulations of the Unified Theory: death is not the opposite of genesis, but the condition of a new genesis when the remaining matter, energy, and information can be reordered into another coherence. This applies at fluid, biological, material, stellar, or cosmic scales, each within the limits of its own description.

The system's great cycle may be formulated as follows:

**genesis → stabilization → interaction → maturation → axialization → limit → decoherence
→ reconfiguration → new genesis**

This sequence does not mean that the Universe repeats the same system. It means that the principle of becoming repeats on different supports, scales, and states. No reconfiguration is a return to the initial point. Every new genesis begins from what remained after the preceding cycle.

19.11. Fundamental principle — Space–Time–Cycle

After all these clarifications, the principle may be formulated in a unified form.

[H] Fundamental principle — Space–Time–Cycle

Every coherent geometrodynamical system must be described simultaneously by its geometry, the transformation of that geometry, and the internal position of the process within its cycle of genesis, adaptation, conservation, limit, decoherence, and reconfiguration. Space describes form, geometrodynamical time describes the transformation of form, and cycle describes the system's becoming.

This principle does not modify the spacetime geometry of current physics. It adds an internal process variable for systems with history, methodologically comparable to a phase or an order parameter, if it can be reconstructed from observables.

Cycle becomes necessary only if it provides predictive information independent of time and of the instantaneous state vector.

In the Unified Theory, cycle is a mandatory addition. It is the variable through which the difference between emergence and maturity, conservation and rigidification, axialization and the Σ_{gd} regime, the death of one state and the birth of another can be tracked. Without cycle, these differences are flattened. With cycle, they become parts of the same geometry of becoming.

19.12. Conclusion — the geometry of becoming

Space–Time–Cycle is the framework through which the Unified Theory can describe not only where a system is and when it is observed, but what it becomes. This third conceptual coordinate is necessary because natural systems are not mere objects placed within a setting. They are processes that are born, adapt, stabilize, become stressed, axialize, disintegrate, and reconfigure.

In the proposed framework, geometry describes the configuration, T_{gd} quantifies reconfiguration, while Cy locates the state within a normalized cycle. The triplet becomes a physical instrument only if T_{gd} and Cy are reconstructed uniquely from observables and add predictive power.

The next chapter will bring this idea down to the problem of geometrodynamical mass, attractors, and witness clusters. If a system is in a process of becoming, we must explain how it becomes locally observable. We must show how mass is captured within the process, how attractors organize accumulation, and how what we call a particle may be understood as the local trace of an extended flow.

Concise formulation

Through delimitation, space shows the form of the system; geometrodynamical time shows the transformation of the form; and cycle shows the internal path through which one form becomes another without losing, up to the limit, the memory of its own coherence.

20. Geometrodynamical mass, attractors, and witness clusters

20.1. From becoming to localization

The preceding chapter introduced space–time–cycle as a description of the becoming of recursive systems. A system is not merely a geometry placed in space, nor merely a process unfolding in time; it is a flow that passes through an internal cycle of genesis, stabilization, interaction, axialization, limit, decoherence, and reconfiguration. This perspective explains becoming, but immediately opens a new question: how does an extended process become locally observable?

Physics observes localized effects. The detector registers a point, a trace, a deposition of energy, a deflection, an impact. Ordinarily, this trace is interpreted as the manifestation of a particle or an ensemble of clusters. The Unified Theory does not deny the local character of the observation, but rejects reducing the process to an isolated material ball or to one part of an ensemble. What appears locally may be the witness of a broader flow, of a geometrodynamical organization extending beyond the site of observation.

For this reason, after genesis, the tree, kinematic correlation, axialization, and cycle, it becomes necessary to define three concepts that link the extended process to the local observable: geometrodynamical mass, the attractor, and the witness cluster. Geometrodynamical mass describes the

matter captured within the process. The attractor describes the region of potential difference that organizes capture. The witness cluster describes the local form through which the flow becomes detectable.

This chapter does not treat mass as a static property of a substance, but as the temporary membership of matter in a transport architecture. It does not treat the attractor as a mystical command point, but as a functional region of capture and accumulation. It does not treat the particle as an ultimate object, but as the local manifestation of a tangle of helical flows. *Through these three concepts, localization acquires a geometrodynamic support.*

20.2. Geometrodynamic mass — matter captured within the process

In the classical description, mass is treated as a property of a body or as the source of the gravitational field. This description is useful and remains operational in domains where the body can be treated as a stable object. *In the Unified Theory, however, systems are defined primarily not as static objects, but as open transport processes. From this perspective, the mass relevant to the system is not simply the matter located within a volume, but the matter captured, retained, organized, and transformed within the process.*

Current physics — Inertial and gravitational mass have precise definitions and tests; in an open system, the mass within a control volume is treated through the density integral and balance equation. Internal organization may modify the effective response, but does not automatically create a new fundamental mass.

Theory proposal — M_{gd} is the inventory of mass that participates functionally in the selected process, within a domain Ω_f defined operationally. It does not replace inertial mass, rest mass, or the gravitational source.

Missing bridge — The criterion for membership in Ω_f , the density, fluxes through the boundary, retention time, and the relationship between M_{gd} and the dynamic observables must be defined.

[F] Test criterion — In an open system, density and IN/OUT fluxes are measured, $M_{gd}(t)$ is calculated, and its variation must satisfy the balance and predict the system's response better than the total mass of the control volume.

The geometrodynamic mass M_{gd} denotes the mass within the functional domain $\Omega_f(t)$, that is, the matter satisfying a measurable criterion of participation in transport or maintenance of the structure. It is a system- and protocol-dependent inventory quantity, not a new type of mass.

Thus, M_{gd} is not equal to the total mass present within a spatial domain. Some of the matter present may not participate in the system's coherence, while another part, although passing rapidly through the system, may play a decisive role in maintaining the flow. Geometrodynamic mass depends on capture, retention time, internal organization, and compatibility with the system's geometry.

Conceptually, we may formulate:

$$M_{gd}(t) = \int \Omega_f(t) \rho(x,t) dV$$

The functional domain $\Omega_f(t)$ contains the matter that satisfies the declared criterion for participation in the process. For a fixed control volume, the minimal balance is:

$$dM_{gd}/dt = \dot{M}_{IN} - \dot{M}_{OUT} + \dot{M}_{sources} - \dot{M}_{losses};$$

for a moving boundary, the corresponding form of the Reynolds transport theorem must be used.

A system may contain a great deal of matter and yet be weakly coherent if it cannot organize it. Conversely, a system may have little mass and yet high stability if the captured matter is transported efficiently and preserves the internal state. *The fundamental criterion is not mass as stock, but mass as organized process.*

20.3. Geometrodynamic mass and mobile scale

Geometrodynamic mass must be understood on the mobile scale introduced in the preceding chapters. At one scale, a cluster may appear as a localized particle. At the higher scale, the same cluster may become a constituent element of a flow. At a lower scale, it decomposes into filaments, smaller tubes, and agglomerations of flows. *In each case, M_{gd} must be defined in relation to the chosen system.*

If we choose an organism, M_{gd} is the matter temporarily integrated into its metabolism. If we choose a star, M_{gd} is the matter captured and reorganized within its internal processes. If we choose a vortex,

M_{gd} is the mass transported and retained long enough to support the geometry of the flow. If we choose a particle-cluster, M_{gd} is the geometrodynamical content of the tangle of flows that gives it localization, inertia, and the capacity for interaction.

This relativity of scale does not make the concept imprecise. On the contrary, it makes it correct. Mass does not abstractly belong to an arbitrarily chosen volume, but to a systemic delimitation. Where we have chosen the system, there we define the interior, exterior, IN, OUT, and the duration of matter's membership in the process. M_{gd} is always the mass of an analyzed flow system, not the mass of a conglomerate of which it is relationally a subsystem.

Therefore, geometrodynamical mass is a relational quantity. It cannot be separated from geometry, transport, attractors, state constants, or the cycle occupied by the system. A mass at genesis does not have the same meaning as a mass in an axialized regime. A mass captured in a node does not have the same function as a mass distributed along branches. Cycle and scale modify the meaning of mass.

20.4. The attractor — potential difference and source of organization

If geometrodynamical mass describes the matter captured within the process, the attractor describes the region that makes capture possible. In the Unified Theory, the attractor is a region, point, or zone of potential difference that attracts and accumulates geometrodynamical mass, becoming the source that organizes transport. It must not be confused with a mere geometric position or a rigid material center.

The attractor appears where there is a functional difference of state. This difference may involve pressure, density, energy, gravitational potential, electromagnetic potential, flow state, or geometrodynamical compatibility. *What matters is that the difference produces orientation. Without a difference, there is no capture. Without capture, there is no accumulation. Without accumulation, there is no organized geometrodynamical mass.*

In the language of kernels, the attractor is linked primarily to C–A, the induction of genesis. Where an incipient flow encounters a potential region capable of concentrating it, the possibility of forming an axis emerges. The attractor is not, by itself, a mature axial flow. It is the condition that imposes the initial direction of capture and prepares the emergence of coherent transport.

We may formulate schematically:

$\mathcal{A}$ + dispersed flow → capture → incipient axis → coherent flow

Here $\mathcal{A}$ denotes the attractor. The sequence shows that the attractor does not merely gather matter, but transforms accumulation into direction. Where matter is merely gathered, there is stock. Where matter is gathered and oriented, there is the beginning of a geometrodynamical transport system.

20.5. The attractor, node, and cluster

Potential differences may exist between numerous regions of a system. In the model, the attractor function may be distributed within the system, and multiple local attractors may arise within a node, at its edge, or in a region favorable to node formation. In every application, the statement must be connected to a defined physical potential and an evolution equation.

A node is a cluster viewed within a network. The attractor is the potential difference that may feed, stabilize, or reconfigure the node. The cluster is the local agglomeration of flows. The three concepts are not identical, but may overlap functionally.

A node may contain multiple local attractors. An attractor may generate a cluster. Through its IN region, a mature cluster may function as an attractor for other external flows. At one scale, what appears as captured mass may become a source of capture at another scale. This is the consequence of recursivity. Nothing is absolutely a node, absolutely a cluster, or absolutely an attractor; the function depends on the scale and relationship being analyzed.

In a geometrodynamical tree, attractors provide directions of capture. Nodes manage the change of scale. Clusters provide localization and coherence. If a node receives compatible flows and organizes them, it may increase M_{gd} . If it receives incompatible flows, it may develop geometric stress. If the stress exceeds the capacity for adaptation, the node may pass through decoherence and generate a new configuration.

Therefore, the attractor must not be treated as a mere external cause. As a dissipative principle, it also participates in the internal architecture of systems. Where potential differences are concentrated,

the direction of the cycle is often decided: genesis, growth, stabilization, excessive accumulation, collapse, reconfiguration, or new flow.

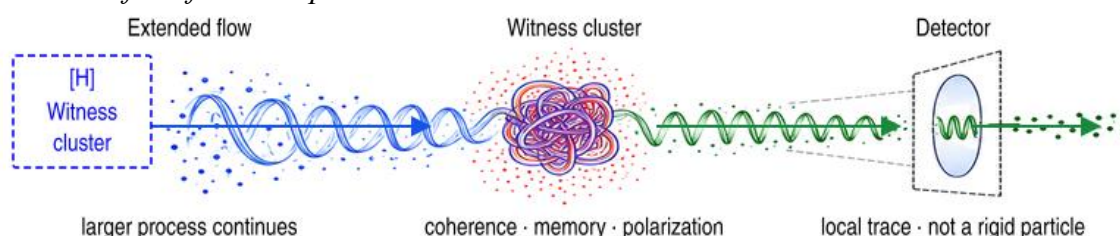
20.6. The witness cluster — localization of an extended flow

The concept of the witness cluster addresses an essential problem: if fundamental reality is geometrodynamic flow, why do we observe localized particle-like effects? The answer proposed here is that the detector does not always capture the entire process, but a local witness of it.

The witness cluster is a local agglomeration of helical flows that becomes sufficiently coherent, dense, or stable to produce a detectable effect. It is not a rigid particle in the classical sense, but a functional localization of an extended flow. It is the point at which a process becomes a trace.

A witness cluster may be viewed as a local node of multiple flow lines. It accumulates geometrodynamic mass, preserves a state memory, displays a marginal polarization, and may interact with other clusters through its flow classes. When observed in isolation, it appears to be an object. When analyzed geometrodynamically, it appears as a helical tangle, a temporary result of the organization of flows.

The designation witness is important. The cluster is not the entire reality of the process, but the local signature through which the process becomes known. Just as a footprint in the sand is not the animal but indicates its passage, the witness cluster is not the entire flow but indicates the existence, state, and compatibilities of the flow that produced it.



From this perspective, what physics calls a particle may be reinterpreted, within the Unified Theory, as the local manifestation of a witness cluster. This reinterpretation does not invalidate experimental results. It changes the conceptual support: the particle is no longer the ultimate object, but the stabilized trace of a flow architecture.

20.7. Localization, measurement, and trace

Measurement is always an interaction. A detector does not passively observe a system, but introduces coupling conditions. It has a typology of materials, surfaces, edges, local fields, absorption thresholds, and compatibility layers. At the quantum level, when a geometrodynamic process interacts with the detector, the entire process need not be captured; only a localization, a witness cluster, may be captured.

Therefore, the observed localization must not automatically be confused with the complete ontology of the process. A point impact on a screen may show the place where the flow became detectable, not necessarily that the entire reality of the light or particle was reduced to that point before measurement. The point is the trace of coupling. The process that led to the trace may be extended, stratified, polarized, and dependent on the geometry of the environment.

This idea allows two levels to be separated: the process level and the witness level. The process may be a helical flow, marginal field, tree, branch, or jet. The witness is the localization where the process produces a detectable effect. Confusing the two has often led to the artificial opposition between wave and particle. In the Unified Theory, the particle is the local witness; the flow is the extended support.

In concise language:

extended process + local coupling → detectable witness cluster

This formulation will be important in the final chapter on applications and experiments, where phenomena such as the slit, edge, detector, and fringes may be read as processes that transform the extended flow into statistically distributed local traces.

20.8. Mass, inertia, and resistance to reconfiguration

Geometrodynamical mass is directly related to the system's resistance to change. A system that has captured and organized a great deal of mass into a coherent geometry cannot be reconfigured without cost. It has memory, internal distribution, polarization, links between branches, and coupling compatibilities. To deflect, accelerate, break, or transform it means placing a demand on the entire architecture that supports M_{gd} .

The theory may explore a geometrodynamical contribution to the transient response of an organized system, but inertia is not redefined here. Any departure from the standard relationship among force, momentum, and acceleration must be formulated quantitatively and separated from deformation, friction, internal energy, and collective modes.

Two systems with the same mass may have different transient responses because of geometry, elasticity, internal distribution, and dissipation. This does not demonstrate different inertial masses; the specific contribution of geometrodynamical organization must be isolated through an experimental protocol.

This idea defines M_{gd} as the inventory of matter participating in the coherent regime. Inertial mass and inertia retain their standard physical definitions; they do not automatically result from membership in Ω_f . [H] The model may investigate whether internal organization produces an additional effective response, but this must be calculated and experimentally separated from total mass, stresses, couplings, and boundary conditions.

20.9. Attractors and witness clusters at different scales

Attractors and witness clusters do not occur at only one scale. In a fluid, a sink may function as an attractor, while the vortex formed may produce localizations of pressure and rotation. In a biological system, a metabolic region may capture substances, organize them, and transform them into local structures. In astrophysics, a gravitational region may attract matter and form disks, jets, or stellar clusters. At the microscopic scale, a local configuration of flows may become what the observer calls a particle.

The difference among these examples lies in the scale and nature of the quantities involved. The principle remains the same: the potential difference produces capture; capture produces M_{gd} ; organization produces a cluster; the cluster's interaction with the environment produces an observable witness. If the system is stable, the witness persists. If the system enters stress, the witness changes. If the system loses coherence, the witness disappears or transforms.

This universality of scale does not mean that all phenomena are identical. It means that they may be read through the same scheme of principle. The planetary attractor, fluid attractor, molecular attractor, and vortex-type attractor are not the same object, but they perform a comparable structural function: they create orientation, capture, and the possibility of organization.

Therefore, the witness cluster must not be understood as a fixed, tiny particle, but as a category of localization. At any scale, wherever an extended flow produces a coherent local effect, a witness may appear. The observer sees the witness; the theory must reconstruct the process that integrated it.

20.10. The attractor and the limit of accumulation

The attractor is not beneficial or stable merely by existing. It can organize, but it can also overload. If it attracts more mass than the system can integrate, geometric stress appears. If M_{gd} increases without a corresponding adaptation of the geometry, the system may lose coherence. Capture then becomes a source of instability.

This situation is important for understanding collapse, fragmentation, and reconfiguration. An excessively strong attractor may concentrate matter until the old structure can no longer preserve its constants. Instead of stabilizing transport, it pushes the system toward decoherence. But decoherence is not an absolute end. It may prepare a new systemic separation, a new flow, and a new cycle.

Thus, the attractor has two faces. In a compatible regime, it is a source of organization. In an excessive or incompatible regime, it becomes a source of stress. In a critical regime, it may become a

gateway to the Σ_{gd} regime. This ambivalence shows that genesis and death are not separated by different mechanisms; they may arise from the same logic of capture and reconfiguration.

A helical system lives geometrodynamically as long as its attractors can be integrated into its adaptation cycle. When capture exceeds the capacity for organization, geometrodynamical mass no longer supports identity, but breaks it apart. From this rupture, another system may be born.

20.11. The witness-cluster localization hypothesis

After these clarifications, the relationship among mass, attractor, and observable may be formulated as a principle.

[H] *Witness-cluster localization hypothesis:*

The witness-cluster hypothesis states that an extended process may produce a detectable localization through the formation of a coherent agglomeration in Ω_f . To become a particle model, it must derive the mass, charge, spin, statistics, lifetime, and interaction cross-sections of the observed state.

[H] *The hypothesis clearly separates three levels. The first is the level of the extended flow, in which the process unfolds as geometrodynamical transport. The second is the level of capture, in which attractors accumulate and organize M_{gd} . The third is the level of the integrated witness, in which the process produces observable localization. Physics often measures the third level; the Unified Theory attempts to reconstruct the first two levels.*

If the observed particle is a witness cluster, a quantitative particle-cluster model had to be constructed: marginal classes, polarizations, and interactions. This requirement led to the development of the unified polarization scheme, which remains a hypothetical classification. To understand the flow in which the witness is confined, it was necessary to formulate a hypothesis supporting its capacity for external interaction through fields.

20.12. Conclusion — the observable as a witness of the flow

Geometrodynamical mass, attractors, and witness clusters form the bridge between the extended process and the local effect. M_{gd} shows what matter effectively participates in the system's identity. The attractor shows the potential difference through which capture and organization occur. The witness cluster shows how this organization becomes detectable.

Through these concepts, the particle ceases to be the endpoint of the explanation. It becomes the beginning of a reconstruction. The observer sees the localization, but the localization indicates a flow. The detector sees the trace, but the trace indicates the process. Measured mass is not merely quantity, but temporary membership in a geometrodynamical coherence.

In its concise form, the chapter's hypothesis is that a particle-like localization might be the witness cluster of an extended process. The statement becomes a particle model only after quantum properties have been derived and differential predictions confirmed.

21. Predictions, experiments, applications, and limits of the Unified Theory

21.1. Why the final chapter is not merely a summary

A theory is not completed by repeating its images, but by exposing itself to experimental risk. A scientific prediction must specify observables, the accepted comparator, the magnitude of the effect, the uncertainty, and the result that would require the theory to be restricted or abandoned.

This chapter uses five status labels: [R] established result; [D] internal definition or identity; [H] hypothesis; [P] differential prediction; [E] experimental protocol. The labels do not represent rhetorical degrees of certainty, but the logical type of the statement.

A statement of the form ‘the phenomenon may be interpreted geometrodynamically’ is not yet a prediction. It becomes [P] only if the model provides a value, a function, or at least the sign of a deviation from the standard hypothesis H_0 before the result is observed.

The role of this chapter is therefore to transform the core of the volume into a critical program: first, direct tests with fluids; then, the classification of interactions and state memory; and only after these stages have been validated, bridges toward optics, quantum theory, and cosmology.

21.2. What remains stable after constructing the volume

[D] The minimal operational core contains the system and tracking protocol, $C_c = dQ/dt$, a single independent rotational descriptor C_r , the kinematic ratio $\eta = v_a/v_t$, orientation S , chirality χ , and phase ϕ . $C_f = rVt^2$ and $C_e = r^3f^2$ are two reporting paths for the same rotational information only when $V_t = 2\pi r f$ and all quantities refer to the same local rotation.

[R/D] The relation $C_f = 4\pi^2 C_e$ is an algebraic consequence of the definitions, not a dynamical prediction. Experimentally, it serves as a consistency check between two measurement chains. $\alpha = C_e C_f / C_c^2$ is a derived dimensionless ratio; it does not preserve the sign of C_c , chirality, phase, or relative orientation and cannot determine coupling by itself.

[H] The testable physical statement is more restricted: for a declared class of flows, protocol, and interval, C_c and C_r might exhibit plateau regimes, while η and relative geometry might contribute to predicting transitions and couplings.

[R] These hypotheses must be compared with the Navier–Stokes equations, conservation of mass, the Reynolds number, swirl number, velocity profiles, and established vortex theories. Helical flow, rotation, and vortex breakdown are known phenomena; novelty can consist only in an additional relationship that improves prediction. [3,4,6,7]

For any observable Y , define the deviation $\Delta Y = Y_{\text{obs}} - Y_{\text{std}}$, where Y_{std} is calculated from the best available standard model, with the same initial and boundary conditions. Parameters are estimated on a calibration set, and the verdict is issued on a separate validation set.

21.3. Differential predictions and decision rules

Rule 1 — the comparator. Every test begins with H_0 , the complete standard model, not with the absence of any effect. Roughness, viscosity, geometry, electromagnetic fields, detector response, and known uncertainties must be included before a residual is attributed to the Unified Theory.

Rule 2 — prediction before data. The sign, interval, or shape of the deviation, the variables analyzed, and the rejection threshold are preregistered. Adjusting the explanation after the result may generate a new hypothesis, but does not confirm the original hypothesis.

Rule 3 — predictive gain. One may use $\Delta M = \text{Err}_{\text{std}} - \text{Err}_{\text{std}} + \text{Pred}_a$, calculated on data not used for fitting. Only $\Delta M > 0$, stable under replication and greater than the complexity penalty, indicates a predictive contribution from the new descriptors.

Rule 4 — locality of the conclusion. Confirmation of a relationship in one class of flows does not automatically validate hypotheses about light, particles, gravity, or cosmology. Each bridge has its own equations and tests.

Rule 5 — publishable negative results. Absence of the effect, protocol instability, and restriction of the domain are results of the program, not failures to be concealed.

21.4. Optical tests: edges, slits, wires, and materials

[R] Diffraction, interference, the influence of material and roughness, slit–obstacle complementarity, and the detector effect have descriptions in electromagnetism and quantum optics. The mere fact that a wire produces fringes or that two materials yield different distributions is not specific to the Unified Theory. [1,16,19,32]

[E] Pairs of apertures and obstacles are constructed with interferometrically measured geometry, varied materials and surface treatments, stabilized illumination, and a calibrated detector. For each configuration, $IEM(x)$ is calculated using a Maxwell model with the measured material properties and boundary conditions.

[P] The strong test is not the presence of fringes, but a specific residual $R(x)=I_{\text{obs}}(x)-I_{\text{EM}}(x)$, reproducible across instruments and laboratories, whose dependence on a geometrodynamical variable is declared before measurement. The residual must exceed the combined uncertainty and must not be absorbed by more complete standard models.

[E] The detector is treated as part of the apparatus: its response function, efficiency, noise, pixel geometry, and any element introduced along the path are controlled. In the single-photon regime, the model must first reproduce the Born rule, Malus's law, and detection statistics. [16–19,32]

[F] If $R(x)$ is compatible with zero, disappears under blind replication, or is explained by material, roughness, alignment, or the detector, the marginal optical hypothesis is rejected in the tested regime. This result does not directly affect the fluid hypotheses.

21.5. The priority test: controlled helical flows

The first decisive experiment must be fluidic, because the proposed variables can be measured directly without assuming an ontology of light or the particle. A transparent apparatus with controlled helical flow, stabilized flow rate, an adjustable swirl generator, and optical access for PIV or LDA is used.

[E] At multiple radii, cross-sections, and times, r , v_t , f , v_a , and Q are measured, together with density, viscosity, pressure, and boundary conditions. Calculate $C_e=dQ/dt$, $C_f=rVt^2$, $C_e=r^3f^2$, C_r , and $\eta=v_a/v_t$. In parallel, report the Reynolds number, swirl number, and standard velocity profiles.

[E] Rotational consistency is evaluated by $\delta f_e=\text{RMS}(C_f-4\pi^2 C_e)/\text{RMS}(C_f)$. The existence of a plateau is evaluated by $\epsilon_r=\text{SD}(C_r)/|\text{mean}(C_r)|$ over the predefined interval. Thresholds are established from the propagation of instrumental uncertainty, not after inspecting the curves.

[P1] For the declared class of flows, the theory predicts intervals in which ϵ_r remains below the preregistered threshold despite controlled variation of the radius. [P2] The two independent measurements of rotation satisfy δf_e within the error limits. P2 mainly checks the protocol and definitions; P1 carries dynamical content.

[P3] Adding C_r , η , and relative geometry to the standard model must reduce out-of-sample error for the transition among coherence, axialization, branching, and decoherence. A descriptive result without predictive gain does not confirm the theory.

[F] If reproducible plateaus do not appear in the declared class, if they disappear after error correction, or if the descriptors add no predictive power beyond standard fluid models, the hypothesis must be restricted or abandoned. [3,6,7]

21.6. Kernels, direction, chirality, and coupling

The four kernels C–A, M–C, C–C, and T–C are candidate classes, not a demonstration of interaction exhaustiveness. The test space must include coaxial, parallel, oblique, noncoplanar, offset, and antiparallel axes, as well as torus–torus configurations and systems with more than two structures.

[E] Each input is assigned the independent state (C_e , C_r , η , S , χ , ϕ), the relative geometry, and the environmental parameters. The output is coded unambiguously: fusion, deflection, reconnection, branching, capture, passage, or disintegration. The classifier is built on one batch and evaluated blindly on new configurations.

[P] If the kernels capture a real structure, they must predict the output type better than a baseline model based exclusively on distance, angle, and intensity. Orientation, chirality, and phase must produce differences with a predeclared sign and magnitude.

α may be included only as an auxiliary derived predictor. To support a coupling role, it must add information after the independent components and geometry have been included; otherwise, it remains a dimensionless summary of the state.

[F] The appearance of stable families of results that cannot be assigned to any kernel refutes the claim of completeness. Performance equal to that of a simple comparator refutes the predictive utility of the taxonomy, even if the diagrams remain suggestive.

21.7. Memory, replication, and conditional applications

[D] A physical variable carries memory only if its states can be distinguished, perturbed, preserved or retrieved, and decoded by a protocol. Conservation of a value alone is not sufficient to demonstrate physical information. [14,15]

[E] For a candidate flow, define a state alphabet, a standard perturbation, a retention time, and a readout rule. Performance is expressed through fidelity, error rate, and mutual information between the written and retrieved states.

[H] The C–C kernel becomes a candidate replication mechanism only if it produces a distinct structure, with finite fidelity, capable in turn of producing an offspring. Heritable variation and differential reproductive success must be observed in a population of flows, not inferred from mere persistence. [25–27]

[P] A two-generation protocol must show that the distance between the parent state and the offspring is smaller than between controls, that introduced variations are inherited above noise, and that the environment reproducibly modifies the replication rates of the variants.

Applications in sensors, materials, fluidic networks, or transport control are conditional on a confirmed effect and an engineering comparison. Similarities to vascular trees, cosmic structures, or living systems remain sources of questions, not demonstrations of the same mechanism.

21.8. Current limits of the theory

In the form presented in this volume, the theory is a conceptual framework with partial operational definitions. C_c has not been demonstrated as a fundamental invariant, C_r has not been shown to be universal, and C_e describes rotation or cyclicity and does not by itself contain the axial advance of a helix.

α is derived and loses sign, chirality, phase, and orientation. The kernels have not been demonstrated to be exhaustive. Axialization does not imply invisibility, and the reduction of a local signature must be defined and measured separately.

The hypotheses concerning the light jet, particle-cluster, unified polarization scheme, tree-like correlation, the Σ_{gd} regime, internal cycle, and geometrodynamical mass have not yet been derived from equations compatible with Maxwell's equations, quantum theory, general relativity, or the Standard Model.

Quantum entanglement is not explained by a classical common origin: any extension must recover the Born rule, violation of Bell inequalities, and no-signalling. [20–24,32]

The Σ_{gd} regime does not replace the relativistic notion of geodesic incompleteness, and analogies with dark matter or superfluidity do not constitute cosmological explanations. [28–31]

No visual similarity across scales demonstrates identity of mechanisms. A conclusion must be limited to the system, regime, and precision in which it was tested.

21.9. Falsification criteria

The following table links each major hypothesis to a differential prediction, the required measurement, and the result that mandates rejection or restriction.

Hypothesis/test	Differential prediction	Measurement	Result that refutes or restricts
C_r plateau	In the declared class, C_r exhibits a radial or temporal plateau beyond that explained by standard parameters.	PIV/LDA; r , v_t , f , ϵ_r , and confidence intervals.	No reproducible plateau appears above instrumental uncertainty.
C_f – C_e measurement consistency	For the same local rotation at the same radius, independently estimated C_f and C_e satisfy the kinematic identity $C_f = 4\pi^2 C_e$ within propagated uncertainty; this is a metrological check, not an independent prediction.	δf_e on the validation set and error propagation.	A deviation beyond the preregistered uncertainty budget reveals a measurement, synchronization, or model-definition failure; agreement alone does not validate the theory.

Hypothesis/test	Differential prediction	Measurement	Result that refutes or restricts
Role of α	α adds predictive power for the coupling outcome after geometry and classical parameters are included.	Out-of-sample error, ΔM , and probabilistic calibration.	$\Delta M \leq 0$ or the effect disappears after controls; α remains only a derived descriptor.
Axialization	An increase in η and a decrease in transverse dispersion precede a quantified change in the selected signature.	η , dispersion, reconfiguration rate, and local signal.	The signature does not change, or the change is fully explained by the standard model.
Kernels	The four classes correctly predict the output type for configurations not used in calibration.	Confusion matrix for fusion, deflection, reconnection, branching, and disintegration.	Stable, systematic classes appear outside the scheme, or the classification does not outperform a baseline model.
Memory/replication	The state is preserved, decoded, and transmitted to a distinct structure, including in a subsequent generation.	State distance, fidelity, error rate, and reproductive success.	Persistence cannot be decoded, or there are no distinct, heritable offspring.
Optical residual	After complete electromagnetic simulation, a reproducible residual associated with the declared geometrodynamical variable remains.	$R(x) = I_{\text{obs}}(x) - I_{\text{EM}}(x)$, edge metrology, and blind replication.	R is compatible with zero or is absorbed by roughness, material, alignment, or detector response.
Quantum entanglement	A geometrodynamical mechanism reproduces the Born rule, CHSH, and no-signalling, then provides a new deviation.	Distributions over variable bases, CHSH value, and analysis without postselection.	The model produces only classical common-origin correlations or permits signalling.

Results are validated using confidence intervals, statistical power analysis, and out-of-sample testing, strengthened by negative controls and experimental replication. An isolated statistical threshold does not replace effect size, robustness, and protocol validity.

21.10. Research program

Stage 1 — metrology and calibration. Construct the fluid apparatus, verify the independent measurement of V_t and f , define the calculation of Q , and propagate uncertainties through C_c , C_r , η , and δf_e .

Stage 2 — regime mapping. Systematically explore flow rate, viscosity, geometry, and swirl; identify candidate intervals without yet calling them universal laws; then test them on new configurations.

Stage 3 — the kernel library. Record interactions with varied relative geometries, build the taxonomy from data, and publish configurations that do not fall within the four classes as well.

Stage 4 — memory and replication. Define written states, retention, decoding, distinct offspring, and two generations. The terms ‘genome’ and ‘Darwinism’ are used without qualification only after these tests have been passed.

Stage 5 — residual optics. Only after a fluid dynamics has been established is the correspondence equation with electromagnetism formulated and residuals relative to Maxwell simulation sought, using blind protocols and external replication.

Stage 6 — fundamental bridges. The hypotheses about light, particles, kinematic correlation, gravity, and cosmology require their own models that recover validated limits and formulate new deviations. They are not confirmed by the success of a fluid analogy.

The program requires preregistration of predictions, publication of data and analysis code, retention of negative results, and independent replication. These practices distinguish a flexible interpretive scheme from a theory capable of cumulative progress.

21.11. Closing the circle

The construction can be evaluated through an evidence scale.

Level A: verified algebraic identity.

Level B: operational definition and reproducible protocol.

Level C: phenomenon observed in the declared domain.

Level D: differential prediction confirmed on new data.

Level E: external replication.

Level F: mathematical bridge to an established theory, with its own predictive advantage.

The theoretical volume reaches levels A and B for some of its quantities and formulates candidates for level C; it does not yet reach levels D–F. This delimitation does not diminish the vision; it specifies the work required for the vision to become a physical theory.

A positive test for C_r or for a kernel validates only the local hypothesis and the measured domain. It does not automatically confirm the light jet, kinematic correlation, fundamental polarizations, or cosmology. The connection among the stages must be demonstrated, not assumed.

The circle closes when the language returns to observation: the system is defined, the variables are measured, the prediction is formulated in advance, the comparator is correct, and reality is allowed to answer ‘no’ as well.

21.12. Final conclusion

This volume proposes a vision in which transport, rotation, axialization, memory, and interaction are organized within a common geometrodynamic language. The originality of this vision is an invitation to formalization and testing, not a substitute for them.

The first experimental wager is modest and decisive: in a controlled helical flow, do reproducible regimes of C_c and C_r exist, and do the proposed descriptors predict transitions better than standard parameters? The answer may strengthen, restrict, or reject the proposed core.

If the advantage appears, the next step is the kernel library and the demonstration of state memory. If it does not appear, the theory must be corrected at its foundation before being extended toward light, particles, and the cosmos.

*The final form of the principle is not a guaranteed conclusion, but a working hypothesis:
flow $\rightarrow$ structure $\rightarrow$ interaction $\rightarrow$ memory $\rightarrow$ reconfiguration.*

Its value will be decided by equations, measurements, and experimental replications.

The Universe may be better understood through flow architectures; this volume offers a possible map. From this point onward, experiment decides which part of the map corresponds to the territory.

Methodological sheet — identification, uncertainty, and reporting

For each regime, report the apparatus geometry, medium, initial and boundary conditions, instruments, sampling rate, analyzed interval, and the rule by which r , v_a , v_t , f , and Q are defined. Parameters are estimated on a calibration batch, and the verdict is established on independent data.

For small, uncorrelated uncertainties, first-order propagation for the two rotational channels is:

$$u(C_f)/|C_f| \approx \sqrt{[(u(r)/r)^2 + (2u(v_t)/v_t)^2]}$$

$$u(C_e)/|C_e| \approx \sqrt{[(3u(r)/r)^2 + (2u(f)/f)^2]}$$

If the measurements share the same radius, time base, or calibration chain, covariances cannot be neglected. Consistency between C_f and $4\pi^2 C_e$ is evaluated using the uncertainty of the difference, not merely the visual proximity of the curves.

$$z_{fe} = (C_f - 4\pi^2 C_e) / \sqrt{[u^2(C_f) + (4\pi^2 u(C_e))^2 - 2(4\pi^2) \text{Cov}(C_f, C_e)]}$$

For C_e , differentiating the flow rate amplifies noise. The differentiation method, filtering, time window, and sensitivity analysis are declared. These relationships establish the minimal metrology; they do not demonstrate conservation of the constants, which remains the tested hypothesis.

Statement of contributions and limitations

The intended original contribution is the construction of a unified language, an operational set of descriptors, a candidate taxonomy of interactions, and an explicit falsification program. Algebraic identities are separated from postulates, and analogies are separated from physical bridges that remain unproven.

The principal limitation at this stage is the absence of a complete dynamics capable of deriving all extensions and quantitatively recovering validated theories. No local fluid result automatically confirms optical, quantum, gravitational, or cosmological hypotheses.

The illustrations have a conceptual role and remain associated with the subchapters for which they were constructed. They synthesize the internal relationship explained in the text, but do not by themselves constitute experimental evidence.

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Glossary

Helical Geometrodynamics — unification of constructive principles

Note on usage. The terms below are defined in the internal sense of the volume. Some words also exist in current physics, fluid mechanics, geometry, or systems theory; here they are used as construction terms of the Unified Theory. The glossary does not replace the demonstration in the chapters, but provides the reader with a quick map of the language.

A

Abrupt adaptation of geometry — A rapid change in the configuration of a helical flow when fine adaptation can no longer preserve the internal state. It may occur through emission, absorption, coupling, or decoupling of vortex-type structures.

Continuous adaptation — Gradual adjustment of the radius, pitch, curvature, velocities, and internal distribution of the flow to preserve coherence. It is the normal regime of a stable flow.

Geometric adaptation — The mechanism by which flow variables change to preserve the state: C_f correlates radius with tangential velocity, C_e correlates radius with frequency, and C_c correlates flow rate with changes in radius and axial velocity.

Vortex tree / tree-like architecture — [H] Proposed global structure consisting of capture roots, transport trunks, distribution branches, and conversion nodes. In the model, the tree expresses the recursive extension of flows; the existence of its levels and their coupling laws must be demonstrated separately at each scale.

Attractor — [D] In the model's vocabulary, a region associated with a potential difference or a capture mechanism, toward which transport is directed. The existence of a potential difference alone does not guarantee mass accumulation; the source, field, balance, and boundary conditions must be specified.

Global axis — [D] Reference direction extracted from a vortex tube, bundle, or vortex tree. Its usefulness requires a reproducible estimation rule and does not automatically imply a physical connection among all filaments or branches.

Axialization — Evolution of a flow toward a regime in which $\eta = v_a/v_t$ increases, while transverse dispersion and the rate of reconfigurations decrease along the same tracked profile. It is not defined by $C_c \rightarrow 0$ and does not automatically imply invisibility or singularity.

B

Bichirality — The capacity of a class of flows to exist naturally in both chiralities. In the volume, bichirality is associated with bosonic-type or predonic-type behaviors.

Helical whip — A regime of lateral/radial decoupling or emission of a flow. Unlike the helical arrow, the whip expresses the lateral component of detachment, reorientation, or jet polarization.

Collective lateral regime (bosonic analogy) — Flow capable of forming stable C–C aggregations. The analogy does not derive integer spin, shared occupation of a state, or Bose–Einstein statistics.

C

C–A, Cylinder–Attractor kernel — [H] Candidate class of genesis in which a region called an attractor would induce the emergence or axial orientation of a cylindrical flow. Its association with system initiation and the capture of geometrodynamical mass is a hypothesis of the internal taxonomy.

C–C, Cylinder–Cylinder kernel — [H] Candidate class of induction and lateral interaction between approximately parallel flows. Replication, aggregation, and the bosonic analogy are hypothetical extensions requiring distinct observables and tests.

C_c — Predecessor descriptor of the rate of change of volumetric flow rate and candidate invariant — Defined by the relation:

$$C_c = \frac{dQ}{dt}$$

It expresses the rate of change of the volumetric flow rate tracked through the same functional cross-section and has the unit $\text{m}^3 \cdot \text{s}^{-2}$. It is not the continuity equation and does not replace conservation of mass. A positive value indicates increasing flow rate, while a negative value indicates decreasing flow rate. The postulated active domain may impose $C_c \neq 0$; steady flows have $C_c = 0$ and remain physically admissible, even if they lie outside that subdomain of the model.

C_f — *Preda descriptor of kinematic form and candidate invariant* — Defined by the relation:

$$C_f = r v_t^2$$

It links local radius to tangential velocity and has the unit $\text{m}^3 \cdot \text{s}^{-2}$. Under the conservation hypothesis, it imposes:

$$v_t = \sqrt{\frac{C_f}{r}}$$

Reducing the radius causes an increase in tangential velocity, while increasing the radius allows it to decrease.

C_e — *Preda descriptor of the internal cycle and candidate invariant* — Defined by the relation:

$$C_e = r^3 f^2$$

where f is the ordinary rotation frequency. The descriptor has the unit $\text{m}^3 \cdot \text{s}^{-2}$ and, under the conservation hypothesis, imposes:

$$f = \sqrt{\frac{C_e}{r^3}}$$

C_e describes the cycle through radius and frequency and must not be confused with the ratio of axial velocity to tangential velocity.

C_r — Independent rotational descriptor used in minimal state vectors. For the same local rotation and the same radius, $C_r \equiv C_f = 4\pi^2 C_e$. It does not replace the two measurement paths: C_f and C_e are retained and reported separately whenever the data allow.

Chirality — The oriented sense of rotation of a helical flow relative to the axial direction. Chirality may be right-handed or left-handed and becomes state information.

Long cycle — The existential cycle of a system: genesis, evolution, stabilization, limit, decoherence, and reconfiguration. It is the system's global history.

Short cycle — An internal oscillation, adaptation, or repetition that participates in maintaining a long cycle. Short cycles construct the system's life cycle.

Cluster — A local agglomeration of coherent helical flows. At one scale it may be observed as a particle, at another scale it may function as a node, and at a higher scale it may become a constituent element of a larger flow.

Witness cluster — The observable localization of an extended flow. It does not exhaust the process that produces it, but represents the local trace or signature through which the process becomes detectable.

Proposed Fundamental Code — Internal taxonomy of minimal forms of interaction among helical flows, expressed through the C–A, M–C, C–C, and T–C kernels. The completeness of the taxonomy has not been demonstrated and must be verified through dynamics and experiments.

Coherence — [D] The operational capacity of a flow to remain identifiable within the chosen protocol and declared tolerances. Linking coherence to geometry, transport, memory, and state constants is the volume's working hypothesis.

α compatibility (hypothesis) — Preliminary scalar filter proposed through equality or proximity of α values. It does not represent complete identity and does not determine coupling by itself. Interaction requires comparison of the independent vector, relative geometry, and kernel dynamics; the effects of incompatibility must be derived or measured, not assumed.

Vortex conglomerate — A complex cluster composed of multiple flows, filaments, layers, and marginal fields. In the unified polarization scheme, the particle is treated as such a polarized conglomerate.

State number α / hypothetical scalar coupling filter — Dimensionless number derived from the Preda triplet:

$$\alpha = \frac{C_e C_f}{C_c^2}$$

α is not a fourth independent constant, but a derived scalar ratio. Its use as a coupling criterion or limit indicator is a testable hypothesis; α does not preserve the sign of C_c , axial direction, or chirality.

Preda constants — internal postulates of the model — The operational triplet:

$$C_P = (C_c, C_f, C_e)$$

composed of three quantities with their own definitions and operational determination paths, sharing the same unit, $m^3 \cdot s^{-2}$. C_c describes the variation of flow rate, while C_f and C_e measure the same rotational constraint through tangential velocity and through frequency. For the same rotation and the same radius, $C_f = 4\pi^2 C_e$; the triplet retains three measurement channels, but only two independent scalar constraints.

Helical flow — [R/D] A flow combining an axial component with a rotational component. In the model, it is proposed as the minimal structure for the joint analysis of transport, stability, and adaptation; its minimality is not a demonstrated universal result.

Marginal flow — A peripheral or enveloping flow surrounding a cluster or conglomerate. Through marginal flows, the cluster interacts with other clusters and with the environment.

Polarized flow — A flow whose inputs, outputs, directions, and marginal fields have a distribution oriented according to a particular pattern. Polarization is field organization, not merely wave polarization in the classical sense.

D

Geometrodynamic Darwinism — [H] Hypothesis of selection through persistence and coherence. The term acquires a properly Darwinian meaning only if measurable replication, heredity, variation, and differential reproductive success exist.

Decoherence — Loss of a flow's capacity to preserve simultaneously its geometry, information/memory, and state constants. Decoherence marks the death of one state and the birth of another.

Tetrahedral distribution of IN/OUT gates — Geometric completion hypothesis: the inputs and outputs of a stable cluster are not arbitrary, but may tend toward equilibrium patterns with simple symmetries, among which the tetrahedral distribution is a minimal candidate.

Geometrodynamic drift — Lateral deviation or local reorientation of a flow under the action of a state difference, an edge, a marginal field, or a system of influence. The whip strike.

Torsional drift — The form of drift in which the perturbation produces a change in orientation, phase, or torsion of a helical flow. F.T.W. is formulated as information of torsional drift.

E

E.F.T. — Fundamental Transfer Helix, the minimal form through which a separated flow can organize an axis, a direction, a chirality, and the IN–path–OUT regions. In the chapter on the Σ_{gd} regime, the first E.F.T. is associated with the first separated transfer of genesis.

Dimensionless internal-state relationship — The definition by which the Preda quantities are combined into a derived ratio:

$$\alpha = \frac{C_e C_f}{C_c^2}$$

Written equivalently:

$$\alpha C_c^2 = C_e C_f$$

The relationship does not replace the values of the triplet, because different states may produce the same value α . It defines a dimensionless descriptor; its coupling role and its role as a limit indicator are additional hypotheses of the model.

Preda effect — Proposed term for the geometrodynamic deflection of a helical jet or flux produced by the marginal fields of a system of influence. It is an experimental bridge among drift, F.T.W., edges, jets, Coandă, and Magnus.

Structural emission — Discharge of mass, a jet, a branch, or a flow fragment from a system. Unlike F.T.W., structural emission transfers structure, not merely deformation.

Tree-like kinematic correlation ('kinematic entanglement') — Classical analogue of distributed correlation among branches with a common origin. It is not identified with quantum entanglement unless it reproduces the Born rule, Bell violation, and no-signalling.

F

Restrictive axial regime (fermionic analogy) — Flow with end-to-end continuity and chiral stability. The analogy does not derive spin, the exclusion principle, or Fermi–Dirac statistics.

Vortex filament — [R/H] A thin region in which vorticity is concentrated, often idealized as a line or thin tube. The additional roles of memory carrier and participant in kinematic correlation are hypotheses of the model.

Vorticity flux — Quantity associated with continuity of rotation through the cross-section of a vortex tube. In an ideal regime, vorticity flux contributes to preserving the vortex structure.

G

Genesis — The emergence of a system through separation, capture, induction, or reconfiguration. In the Unified Theory, genesis is not merely the appearance of an object, but the emergence of a delimited flow capable of transport and information/memory.

Geometry as an expression of transport — [H] Internal principle according to which the observed form may result from transport constraints. The statement becomes predictive only when the equations, boundary conditions, and standard comparator are specified.

Helical geometrodynamics — [D/H] Proposed theoretical framework in which geometry, motion, transport, and memory are described together. Choosing helical flow as the central constructive support is the organizing hypothesis of the volume, not an established result.

Helical tangle — [H] Compact configuration proposed for a conglomerate of helical flows. Identifying it with a particle-cluster requires a model of fields, energy, stability, and observables compatible with particle physics.

Gravitonic / gravitonic flow — Hypothetical class of marginal flows associated with POL-A within the unified polarization scheme. The term denotes a proposed internal class, not a derivation of classical or relativistic gravity.

H

Helicity — [R] An integral quantity of a velocity and vorticity field, related in certain configurations to linking, twisting, and writhing. Its exact conservation depends on the regime, boundaries, and ideality; use of the term 'memory' is the functional interpretation of this volume.

Homochirality — Dominance of a single chirality within a class of structures. In the volume, the idea is methodologically associated with monochiral behaviors and selection through compatibility.

I

Kinematic identity — The set of independent characteristics that allows a flow to be recognized as the same state during transformation: C_c , C_r , η , axial direction, chirality, and phase. C_f and C_e remain the operational channels of the rotational descriptor.

Flow idealization — A theoretical limit in which dissipation is neglected to highlight conservation laws, invariants, and states of coherence.

IN-path-OUT — The functional architecture of an open flow: input/capture, internal transport, and output/redistribution. It is the skeleton of any coherent geometrodynamic system.

Geometrodynamic information — The concrete value of the independent vector and the topological constraints of a flow. The Preda triplet provides operational measurement, while α may be calculated as a derived diagnostic. The coexistence of memory and information is a physical hypothesis that must be linked to observables.

Invariant — A quantity or relationship preserved during a coherent transformation. In the volume, invariants may be topological, kinematic, or geometrodynamic.

Horizontal interaction — [D/H] Internal label for lateral or transverse interactions. Their association with replication, emergence, and bosonic behavior is analogical and requires its own tests.

Perpendicular interaction — [D/H] Internal label for cylinder–torus configurations with approximately perpendicular axes. Conversion of the dynamics and transverse balancing are hypotheses of the T–C kernel.

Vertical interaction — [D/H] Internal label for axial, end-to-end interactions. Continuity may be tested kinematically; the fermionic analogy does not imply spin or Fermi–Dirac statistics.

J

Helical jet — [D/H] Coherent flow fragment with a helical structure. Reinterpreting light as a helical jet and the wave as a kinematic projection is a hypothesis that must recover electromagnetism and quantum optics.

Photonic jet — [H] Hypothetical helical-jet regime associated with light. Its helical signature, drift, and ‘arrow’/‘whip’ types must be quantitatively derived and compared with the predictions of electromagnetism and quantum optics.

K

Geometrodynamic kernel — Proposed schematic operator for classifying interactions among helical flows. The kernels describe genesis, axial continuity, lateral replication, and torus–cylinder conversion; they become complete physical operators only after the dynamics and quantitative predictions are defined.

L

Linking number, L_k — Mutual linking number that measures the degree of linking between two distinct vortex lines or tubes. Its contribution to total helicity is treated separately from the self-linking $T_w + W_r$ of each tube.

Localization — The appearance of an observable trace in a region of space. In the Unified Theory, localization does not exhaust the extended process, but expresses it through the witness cluster.

Localization through a witness cluster — The local observable is not the entire process, but the witness cluster through which an extended flow becomes detectable at a point or within a region.

M

M–C, Multiple–Cylinder kernel — [H] Candidate class of interaction through axial continuity between flows arranged end to end. Its association with fermionic chains is analogical and does not derive quantum properties.

Magnetonic / magnetonic flow — Class of marginal flows associated with bipolar polarization POL-1. The term denotes the geometrodynamic level of magnetic-type behaviors.

Geometrodynamic mass, M_{gd} — The inventory of mass within the functional domain $\Omega_f(t)$, defined by $M_{gd}(t) = \int \Omega_f(t) \rho \, dV$ and by an IN–OUT balance. It is system- and protocol-dependent; it does not replace inertial, rest, or gravitational mass.

Geometrodynamic memory — The capacity of a flow to preserve the independent components of its state and its topological constraints during transformation. α may be calculated from the Preda quantities, but does not constitute an independent component of memory.

Peripheral memory — Information stored in the marginal layers, envelopes, or peripheral fields of a cluster. It is important for the four types of polarization in interactions with the external environment.

Topological memory — Information preserved through helicity and its components: the self-linking of a tube, expressed by $T_w + W_r$, and the mutual linking L_k between distinct tubes. It describes how vortex lines are twisted, writhed, and linked.

Vortex core — The central region of a flow or cluster, where internal coherence is most concentrated. The core is surrounded by marginal layers and flows.

Unified polarization scheme — Internal and provisional classification of the marginal distributions POL-1, POL-2, POL-A, and POL-B. It is not the Standard Model of particles and has not been demonstrated to be exhaustive.

Monochirality — A regime in which a class of flows appears naturally in only one chirality. It is associated with fermionic behaviors, directional selection, and the construction of long chains.

N

Node — A cluster analyzed as a point in a network or tree. The node localizes, selects, converts, and redistributes flows among branches or scales.

Capture node — A node associated with the IN region, where dispersed flows are gathered, oriented, and prepared for coherent transport.

Distribution node — A node associated with the OUT region, where the flow branches and is transmitted to subbranches, networks, or secondary systems.

Passage node — A node that stabilizes transport without a major change of scale or class. Its function is continuity.

P

Particle-cluster — [H] Proposed reinterpretation of the particle as a localization of coherent helical flows. The model becomes physical only if it reproduces particle properties and provides new predictions without violating the validated limits of current theories.

POL-1 — Bipolar polarization associated with monochiral (fermionic) flows of the same direction (parallel). It expresses an organization with two dominant poles, of input and output type, through polar attraction/repulsion-type behavior. Possible candidates are magnetic flows.

POL-2 — Complementary multipolarization in the unified polarization scheme. It is associated with bichiral (bosonic and predonic) flows of opposite directions (antiparallel). The poles are multiple and take the form of vortex bouquets, genuine input or output tornadoes arranged according to equilibrium patterns.

POL-A — Multipolarization associated with monochiral (fermionic) flows of opposite directions (antiparallel). It expresses a distribution with a great many inputs and outputs. There are not merely two poles; their number may be at most equal to the number of fermionic flows. Possible candidates are gravitonic flows.

POL-B — Stratified bipolar polarization, with rotating enveloping fields organized into marginal layers. It is associated with bichiral (bosonic and predonic) flows of the same direction (parallel). It has two dominant poles connected by layers. Much smaller particle-clusters may remain confined on these rotating layers and be detected as having ring-shaped trajectories. Possible candidates are flows around atomic nuclei and planetary/stellar-type conglomerates displaying rings or rotating external dynamics.

Polarization of conglomerates — The global organization of a cluster's marginal flows, inputs, and outputs. It is not the polarization of classical waves, but the geometrodynamical distribution of flow poles.

IN/OUT gates — Regions through which a cluster receives or emits flows. In a stable cluster, the gates are not completely random, but may be ordered by internal balancing, chirality, and polarization.

R

Coherent branching — Division of a flow into branches that preserve a common origin, distributed memory, and state compatibility.

Helical ratio η — Dimensionless kinematic descriptor and principal parameter of axialization, defined by:

$$\eta = \frac{v_a}{v_t} = \frac{p}{2\pi r}$$

It expresses the ratio between axial transport and tangential motion. η is an additional descriptor and must not be identified with C_e .

Reconfiguration — The emergence of a new state after the decoherence or death of a previous state. Reconfiguration entails a new set of constants or a new flow geometry.

Reconnection — A change in connectivity among vortex lines, branches, or filaments. It may preserve certain global principles, but changes the concrete value of the old structure's identity.

Geometrodynamical recursivity — [H] Hypothesis according to which some systems may exhibit analogous organizations across successive scales. Visual similarity does not demonstrate the same dynamics, and each level requires its own variables and scaling laws.

Reconfigurable chiral regime ('predonic') — Internal term for a state whose chirality can be reversibly inverted in a controlled manner without loss of the defined identity. It does not denote a new physical particle.

Filamentary regime — A highly axialized transport state, with a high η ratio and reduced transverse dispersion. Its detectability must be established experimentally and does not follow automatically from the definition.

S

Mobile scale — A method of analysis through which the system chosen at one scale may be taken downward toward its constituent structures or upward toward higher-scale flows and networks.

Axial direction — The dominant direction of flow along the axis. Axial direction is oriented information and a condition for defining chirality.

Geometrodynamical transition regime, Σ_{gd} — Postulated interval between the loss of stability of one state and the stabilization of another. It is not a mathematical singularity and does not claim to resolve relativistic singularities.

System — A delimited domain of analysis, with an interior, exterior, processes, and exchange relationships. In the volume, the system precedes the object as the fundamental unit of intelligibility.

Open system — A system that exchanges mass, energy, momentum, information, or state with the environment. Natural systems are treated as open, not as isolated objects.

Geometrodynamical system — A system whose identity is defined through geometry, flow, transport, memory/information, and adaptation.

Space–Time–Cycle — A conceptual framework in which space expresses geometry, time expresses geometric transformation, and cycle expresses the system's internal position in its own becoming. A proposed framework in which $Cy \in [0,1)$ is a normalized internal coordinate reconstructed from observable state thresholds. Cy is not a demonstrated spacetime dimension and is justified only by additional predictive power.

Geometrodynamical species — A group of flows sharing compatible domains of the independent vector ($C_c, C_r, \eta, S, \chi, \phi$) and a dominant kernel. α may be reported as a derived diagnostic.

Extended state — Independent description of a flow through ($C_c, C_r, \eta, S, \chi, \phi, \dots$), supplemented as appropriate by the chiral class, contact region, and kernel. The Preda triplet remains the operational measurement format, while α is derived.

Marginal layers — Envelopes or peripheral regions of a cluster where field flows are distributed in layers. They are important for marginal, external interactions.

Geometric stress — Internal tension produced when a flow is forced to adapt beyond its conservation capacity. Geometric stress precedes decoherence or reconfiguration.

Geometrodynamical subspecies — Fine differentiation within a species, determined by variations of the independent vector, polarization, or interaction history.

Superfluidity / dark transport — Analogy and hypothesis of axialized transport with reduced transverse dispersion. It does not imply impossibility of detection; it requires observables, an energy balance, and a differential prediction relative to superfluidity and standard cosmology.

Supergravitonic multipolar class — [H] Internal label for the hypothetical POL-2 multipolar regime. It does not denote supergravity in supersymmetric field theory and has no established physical status. A field, source, propagation law, coupling, observables, and falsification criteria must be specified before the term can be used as a physical classification.

Helical arrow — A regime of axial emission or decoupling of a helical jet. It is the coherent directional component associated with transfer along the axis.

T

T–C, Torus–Cylinder kernel — [H] Candidate class of interaction between a toroidal and a cylindrical structure. Conversion in both directions and the linkage of axial regimes to toroidal forms must be demonstrated through dynamics and experiment.

Taxonomy of helical flows — Classification of flows according to state information: constants, α , chirality, direction, dominant kernel, polarization, and interaction regime.

Geometrodynamical time, T_{gd} — Internal parameter of geometric change between two states. $T_{gd}=0$ means the absence of detectable reconfiguration in the selected protocol, not the cessation of physical or proper time.

Vortex torus — An apparently closed or nearly closed flow structure associated with the cycle, recirculation, and T–C conversions.

Geometrodynamic transport — Organized transfer of mass, energy, momentum, information, or state through an adaptive geometry. Transport is the function that compels the form to emerge.

Preda triplet — The set $\mathbf{C}_P = (\mathbf{C}_c, \mathbf{C}_f, \mathbf{C}_e)$, proposed as a primary kinematic identity. The three quantities have their own determination paths and remain operationally distinct; when $\mathbf{C}_f$ and $\mathbf{C}_e$ describe the same rotation at the same radius, they are algebraically correlated and do not represent independent degrees of freedom.

Kinematic compatibility note

If tangential velocity and frequency describe the same local rotation at the same radius, then:

$$v_t = 2\pi r f$$

and it follows that:

$$C_f = 4\pi^2 C_e$$

This is a verification relationship between two measurement paths, not a redefinition of one constant through the other. In this particular case, the equation for α may be written equivalently:

$$\alpha = \frac{4\pi^2 C_e^2}{C_c^2} = \frac{C_f^2}{4\pi^2 C_c^2}$$

Vortex tube — A coherent helical-flow structure, with IN, path, and OUT, formed from vortex lines or filaments. It is the volume's minimal geometrodynamic transport system.

Twist, T_w — A component of self-helicity describing the internal twisting of a vortex filament or tube around its own axis. Together with W_r , it forms the self-linking number $SL = T_w + W_r$.

U

F.T.W. — Fundamental Torsion Wave — Deformation information, a torsional drift, transmitted through lateral interactions, especially of the C–C type. F.T.W. is not a mass emission and is not identical to the photonic jet.

Wave as projection — A reinterpretation according to which the observed wave may be the kinematic projection of a helical process. For light, the wave is the geometric shadow of the helical jet.

V

Vortex — [R/D] A region in which the velocity field exhibits organized rotation. In the Unified Theory, the vortex is proposed as the minimal form of dynamic coherence; its minimality is a hypothesis of the framework.

Vorticity — A local quantity describing the rotation of a velocity field. It is the local signature of vortex character.

Writhe, W_r — A component of self-helicity describing the coiling, bending, or meandering of the axis of a vortex filament or tube. Together with T_w , it forms the self-linking number $SL = T_w + W_r$.