

Resonance Field Dynamics and Stability Conditions: A Coherence-Based Framework for the Geometry of Matter

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Abstract

This work develops a resonance-based field framework in which the structure and stability of matter arise from coherence conditions within a continuous field defined on a three-dimensional spatial manifold. Rather than introducing additional spatial dimensions, the framework incorporates an internal coherence parameter, denoted ζ , representing sequential field-depth organization without extending geometric dimensionality.

Within this formulation, stable physical structures are interpreted as self-coherent resonance nodes governed by the interplay between spatial (lateral) and internal (sequential) coherence gradients. Structural configurations—ranging from atomic arrangements to crystalline lattices and biomolecular geometries—emerge as preferred stability states determined by resonance equilibrium rather than purely local energy minimization.

A generalized stability condition is introduced through a self-coherence functional, whose stationary solutions define irreducible resonance configurations. These configurations exhibit nodal stability, discrete structural selection, and rapid convergence behavior consistent with observed phenomena such as crystallization, symmetry formation, and molecular organization.

The framework provides a unified geometric interpretation of mass, interaction behavior, and structural identity as consequences of coherence geometry within the field. Stability is thus treated as a global resonance condition rather than a local potential minimum, offering a coherent mechanism for the emergence of ordered structures across physical, chemical, and biological systems.

The framework further suggests the possibility of **predictive structure identification**, where stable molecular, crystalline, and material configurations may be determined from coherence conditions rather than empirical discovery alone. *This shifts structural science from descriptive classification toward predictive design based on fundamental stability principles.*

1. Introduction

The emergence of stable structure in physical systems—ranging from atomic lattices and molecular geometries to large-scale material organization—remains one of the most fundamental and unresolved questions in physics. Conventional frameworks typically describe stability as the result of local energy minimization within three-dimensional (3D) interaction spaces. While successful in predicting equilibrium states, these approaches do not fully explain the discrete, highly ordered, and rapidly established configurations observed across physical systems.

In established chemistry and quantum theory, molecular structure is typically described through orbital models and valence-based frameworks such as VSEPR [4], where geometry emerges from electron distribution and energy minimization. While highly successful in predicting molecular shapes, these approaches do not provide a direct physical mechanism explaining why such discrete geometries arise or why specific angular configurations are selected.

The present framework offers an alternative interpretation in which molecular geometry is not imposed through orbital rules or electron repulsion models, but instead emerges from coherence-driven stability conditions within the field. In this view, structures traditionally described by orbital hybridization or VSEPR constraints correspond to stable resonance configurations formed by electron-mediated coherence interactions within the Field Matrix. The role of wave interference in determining crystal structure has long been established, most notably through X-ray diffraction and Bragg's law[1-2, 5], which demonstrate that structural geometry is intimately linked to interference conditions within periodic systems.

In particular, phenomena such as abrupt symmetry formation, nodal precision in crystal structures, rapid molecular folding, and phase-locked coherence transitions suggest that stability may not arise solely from local energetic descent. Instead, these behaviors indicate the presence of deeper organizing principles governing structural selection.

In earlier formulations of the present work, this organizing mechanism was described using a four-dimensional resonance domain. However, further theoretical development has shown that the essential features of the model do not require the introduction of an additional spatial dimension. Instead, the underlying structure can be more consistently formulated through an internal coherence parameter, denoted ζ , which represents sequential organization within the field without increasing geometric dimensionality.

This shift leads to a more physically grounded interpretation: observable structure arises not as a projection from a higher-dimensional space, but as the manifestation of self-coherent resonance configurations within a single field defined on a three-dimensional manifold.

Within this framework, physical systems are described by a continuous field supporting two complementary forms of coherence:

- **lateral coherence**, corresponding to spatial phase structure in three dimensions, and
- **sequential coherence**, corresponding to internal organization along the parameter ζ .

Stable configurations emerge when these coherence structures reach equilibrium, forming standing resonance nodes that act as attractors for structural organization. Matter is therefore

not constructed from fundamental point-like entities, but from stable resonance patterns whose geometry determines physical properties such as mass, interaction behavior, and structural identity.

In this interpretation, orbital structures do not represent fundamental probability distributions, but projections of underlying resonance configurations.

The purpose of this work is to formalize this coherence-based stability framework, establish general conditions for resonance-driven structural formation, and demonstrate how a wide range of physical phenomena can be interpreted as consequences of nodal coherence within a unified field description.

2. The Resonance Field and Coherence Structure

2.1 The Resonance Field

We define a continuous scalar field:

$$\Phi = \Phi(x, y, z, t; \zeta)$$

where (x, y, z) describe a three-dimensional spatial manifold, t denotes time, and ζ is an internal coherence parameter.

Crucially, ζ does not represent an additional spatial dimension. It does not extend the geometry of space, nor does it introduce independent directions of motion. Instead, ζ characterizes the internal coherence structure of the field—its capacity to support stable, self-consistent resonance configurations.

All physical processes remain embedded in three-dimensional space. The role of ζ is to encode how strongly a given configuration is internally stabilized.

2.2 Dual Coherence Architecture

The field supports two fundamentally distinct forms of coherence:

- **Lateral coherence:** spatial phase structure within (x, y, z) , governed by gradients

$$\nabla_{xyz} \Phi$$

- **Sequential coherence:** internal organization along ζ , governed by

$$\partial_{\zeta} \Phi$$

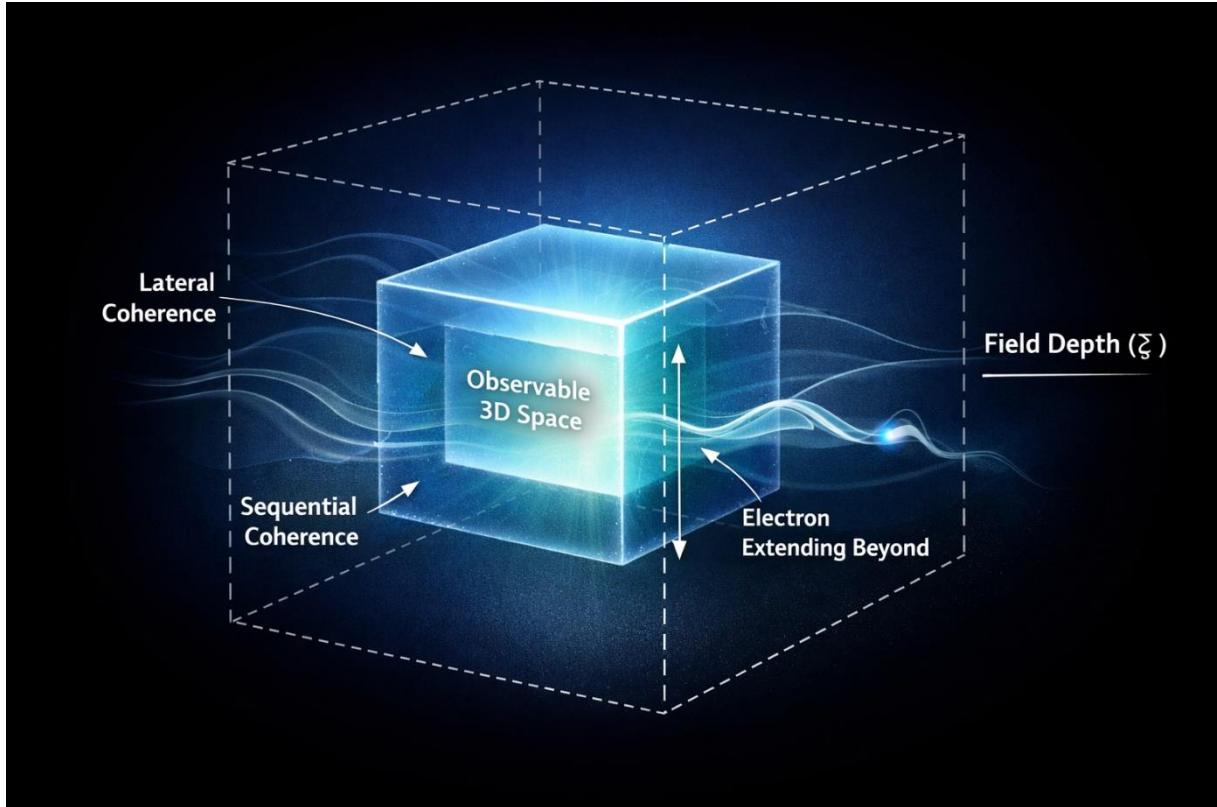
These two coherence modes serve different physical roles:

Coherence type Physical role

Lateral	Spatial interaction, geometry, and force-like behavior
Sequential	Stability, persistence, and structural identity

Observable physical behavior arises from the **balance and interaction** between these two coherence structures.

Figure 1 Coherence architecture of the resonance field.



The field is defined over a three-dimensional spatial manifold (x, y, z) and an internal coherence parameter ζ . Lateral coherence governs spatial phase relationships, while sequential coherence represents internal field-depth organization. Importantly, ζ does not correspond to an additional spatial dimension, but to an intrinsic coherence structure of the field. Stable configurations arise from the balance between these two coherence modes. The electron in contrast to the proton and neutron can move in and out from the extended Field Depth.

2.3 Stability as a Coherence Condition

In conventional physics, structure is often described as the result of local energy minimization. In the present framework, structure instead arises from **global resonance stability**.

We define a generalized coherence functional:

$$\mathcal{S}[\Phi] = \alpha |\partial_{\zeta} \Phi|^2 + \beta |\nabla_{xyz} \Phi|^2 + \gamma \omega^2$$

A configuration is stable if:

$$\mathcal{S}[\Phi] \geq S_{\text{crit}}$$

and if it cannot decompose into lower-order resonance modes. This defines an **irreducible resonance state**.

Such states are not imposed; they emerge naturally as the only configurations capable of sustaining internal coherence.

2.4 Resonance Nodes as the Basis of Matter

Stable physical structures correspond to **resonance nodes**—localized regions where coherence is self-sustained.

A resonance node satisfies:

- stationary behavior along ζ
- non-zero spatial structure
- internal self-coherence under perturbation

These nodes are not particles in the traditional sense. They are **standing resonance configurations** of the field.

Matter is therefore not composed of fundamental objects, but of **stable patterns of coherence**.

2.5 Three Structural Node Types

The field admits three distinct node classes:

(1) Repeller Nodes

- Strong sequential coherence
- High stability
- Generate spatial gradients
- Correspond to particle-like structures

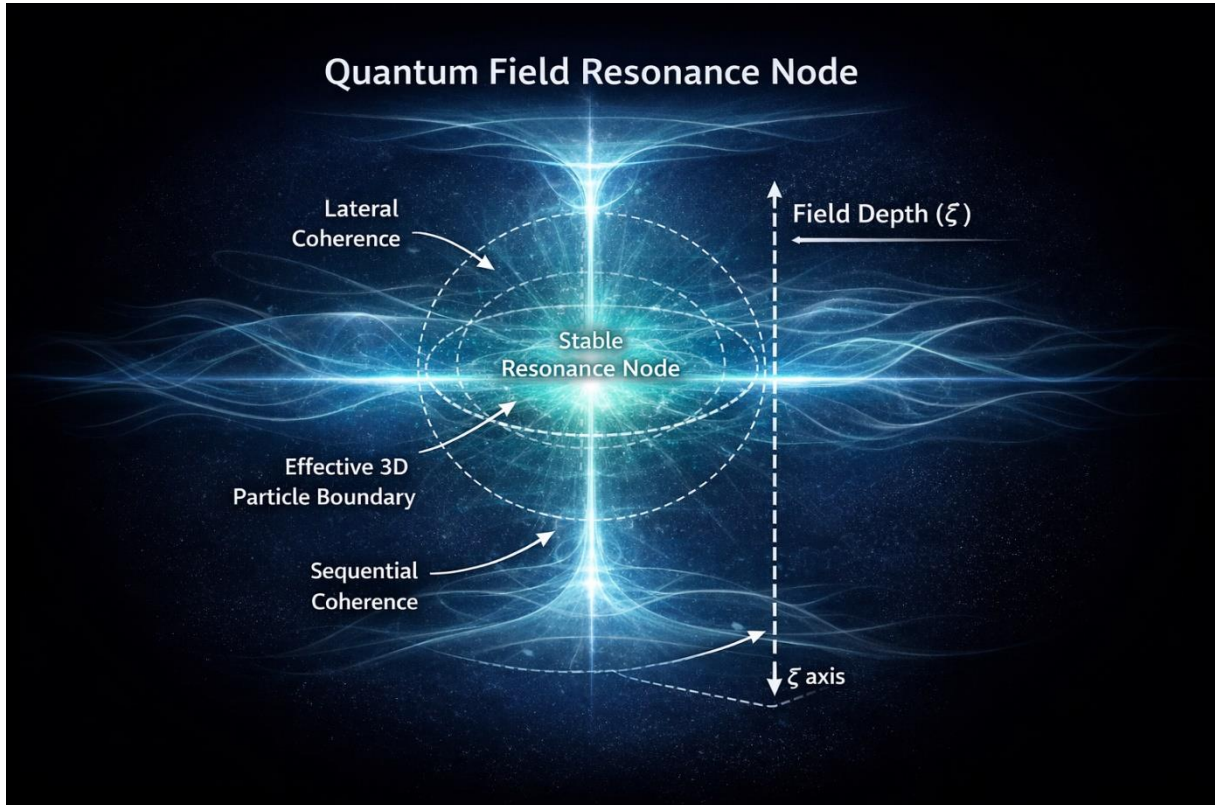
(2) Harmonic Nodes

- Minimal-energy configurations
- Spectral reference states
- Do not generate strong interactions
- Guide system stability

(3) Self-Coherence Structures

- Adaptive coherence envelopes
- Arise between interacting nodes
- Enable binding and stabilization

Figure 2 Resonance Node as a Coherence-Stabilized Field Structure



A stable resonance node is shown as a localized region of self-sustained coherence within the field. The central region represents the effective three-dimensional manifestation of the node, while surrounding structures illustrate its extended coherence across the internal parameter ξ (field depth).

The distributed wave-like structures visible throughout the image represent **lateral coherence**, which fills space and governs spatial phase relationships across the field. The lateral coherence extension that moves outwards illustrates that it is the lateral coherence that gives surface and interaction with other nodes. The electron has a very large extension in the lateral coherence.

In contrast, **sequential coherence** reflects internal stabilization along ξ and determines the persistence and stability of the node. Importantly, ξ does not represent an additional spatial dimension, but an intrinsic coherence structure of the field.

The apparent “particle boundary” corresponds to the region where coherence remains sufficiently localized to produce observable three-dimensional effects, while the full resonance structure extends beyond this boundary into the surrounding field.

2.6 Origin of Geometric Structure in Matter

A key distinction of the present framework is that resonance nodes themselves are **stable, persistent structures**. Once formed, they do not continuously reorganize or fluctuate arbitrarily.

Instead, structural formation arises from the response of the surrounding Field Matrix (FM) to the presence and interaction of these stable nodes.

In particular, certain node classes—most notably electron-like resonance configurations—exhibit extended coherence across the internal parameter ζ . Unlike strongly localized nodes, these structures are not confined to narrow coherence regions but interact with the Field Matrix across a broader coherence depth.

This extended coherence allows them to act as **structural mediators**, influencing how the Field Matrix redistributes coherence in space.

As a result:

- Nodes themselves remain stable
- The Field Matrix reorganizes around them
- Structural patterns emerge from this reorganization

2.7 Field-Mediated Structure Formation

When multiple stable nodes interact, the Field Matrix responds by forming **dual-node configurations and coherence envelopes**.

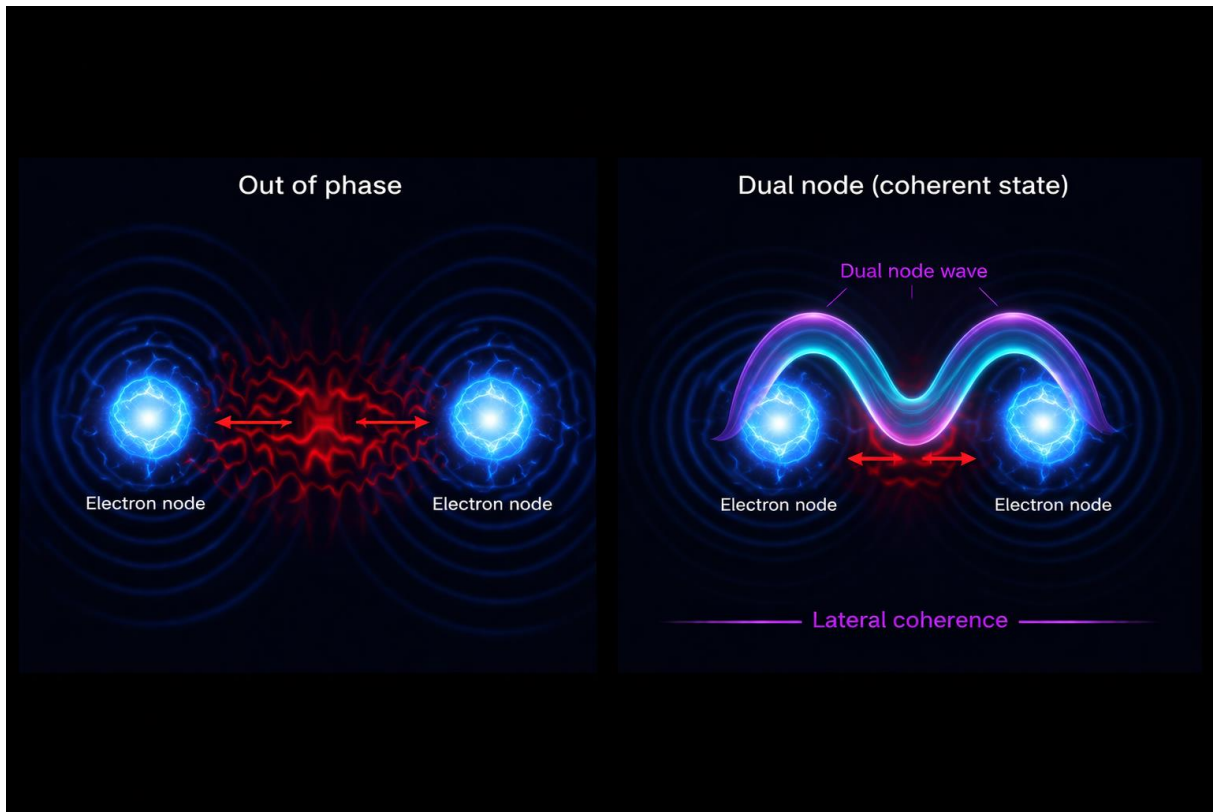
These are not new particles, but emergent field structures that arise to restore coherence balance.

The key mechanism is:

1. Stable nodes generate coherence gradients
2. The Field Matrix reacts to imbalance
3. Dual-node structures form as stabilizing responses
4. These structures define spatial organization

Thus, structure is not built directly from particles alone, but from the **interaction between stable nodes and the Field Matrix response**.

Figure 3 Dual-node formation in electron–electron interaction.



Left: Two electron-like resonance nodes in an out-of-phase configuration exhibit repulsive interaction. The surrounding lateral coherence field remains continuous, but phase mismatch between nodes leads to instability and separation.

Right: A dual-node configuration emerges as a coherent wave structure forms over both nodes. This structure does not eliminate repulsion, which remains present between the nodes, but redistributes coherence in a way that stabilizes the system. The dual-node wave extends over each node and between them, creating a balanced configuration that allows reduced separation while maintaining internal coherence.

The lateral coherence field persists throughout both states, indicating that structure arises not from the removal of interaction, but from the formation of stable resonance patterns within it.

To bind neutrinos it takes only small wave structures, gravity but for protons big wave structures, the strong force. But when neutrinos and protons meet the waves increase dramatically and in stars they can give rise to exceptionally strong waves.

2.8 Electron-Dominated Structural Geometry

A central consequence of this framework is that not all nodes contribute equally to structure formation.

Electron-like resonance nodes play a dominant role because:

- they extend across a larger coherence depth (ζ)
- they drive coherence redistribution over spatial regions

This gives them a disproportionate influence on geometry.

As a result, the spatial structures we observe—such as:

- molecular bonding
- crystal lattices
- and helical biomolecular forms. This transition is illustrated in Figure 4.

are largely shaped by the coherence behavior of electron-like nodes.

2.9 Apparent Higher-Dimensional Geometry

Because electron-like structures interact across extended coherence depth, the resulting spatial organization exhibits properties that appear higher-dimensional when viewed in three-dimensional space.

This does not imply the existence of an additional spatial dimension.

Instead, it reflects the fact that:

the Field Matrix is being structured by nodes whose coherence extends beyond purely local spatial interactions.

This produces geometries that resemble projections of higher-dimensional organization.

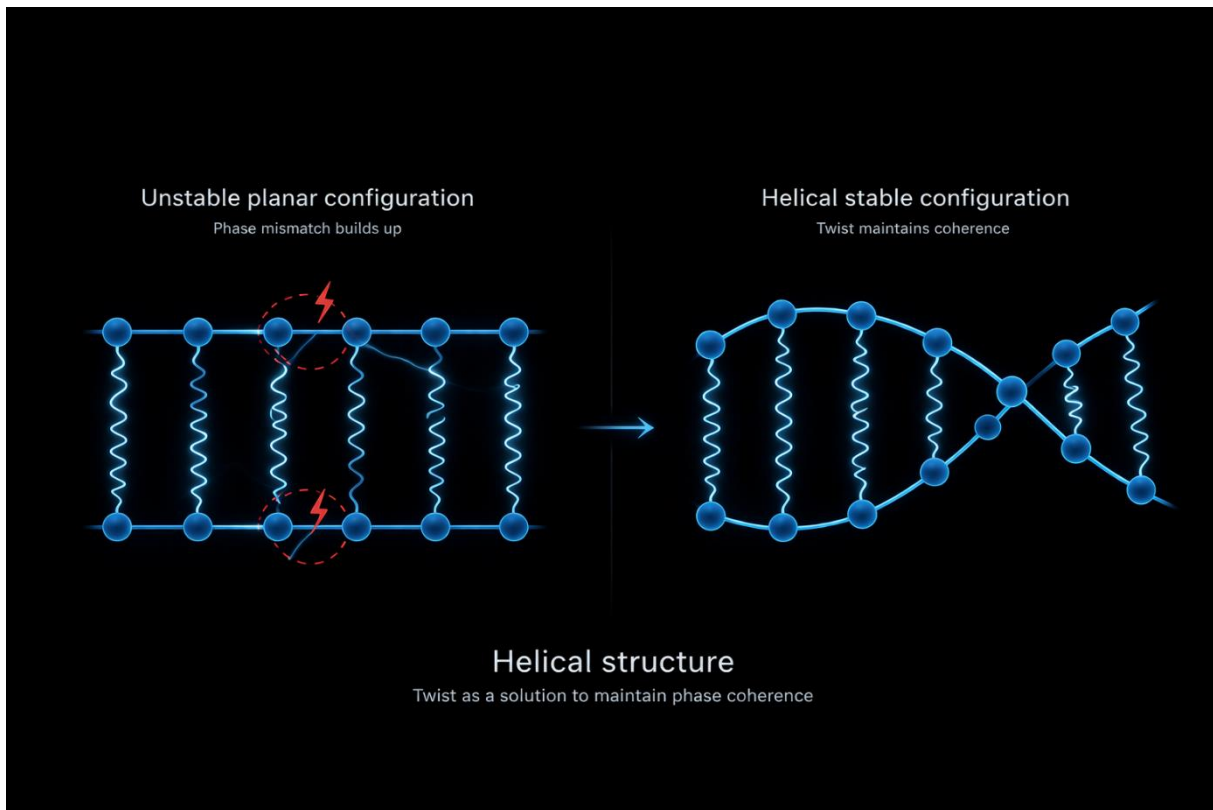
A clear example is the DNA helix:

- its structure cannot be understood solely as a local 3D minimization problem
- it reflects a coherence-driven organization influenced by extended field-depth interactions

Thus:

The apparent “four-dimensional” nature of certain structures arises from internal coherence geometry, not from additional spatial dimensions.

Figure 4. Helical structure as a coherence-stable solution.



Left: a planar configuration accumulates phase mismatch and cannot maintain stable coherence over extended structure. Right: twisting into a helical arrangement redistributes the phase relation and allows a stable coherence pattern to persist. In this interpretation, the helix is not merely a geometric outcome, but a structural solution to a resonance constraint.

2.10 Summary of Structural Mechanism

The formation of matter follows a layered mechanism:

- Stable nodes exist as persistent resonance structures
- The Field Matrix responds to their interaction
- Dual-node and coherence envelopes form dynamically
- Electron-like nodes drive large-scale structure
- Observable geometry emerges from coherence-driven organization

3. Electron Structure and Coherence Projection

3.1 Electron as a Resonance Node

Within the resonance field framework, electron-like entities are not treated as point particles, but as stable standing-wave configurations of the field. This interpretation is consistent with wave-based descriptions of matter and extends earlier resonance-based formulations [6-7], where electron structure is described as a standing coherence configuration.

These configurations are characterized by:

- persistent coherence along the internal parameter ζ
- extended spatial influence
- stable phase structure

Unlike more localized nodes, electron-like structures are not confined to narrow coherence regions. Instead, they occupy a broader coherence domain, allowing them to interact strongly with the surrounding Field Matrix.

This extended coherence is the key property that enables electrons to act as primary structural mediators.

3.2 Projection and Observed Electron Density

The spatial electron density observed in atoms and molecules is not a fundamental probability distribution, but a projection of a deeper resonance structure.

Following the formulation:

$$\rho(x, y, z) = \int |\Psi(x, y, z, \zeta)|^2 d\zeta$$

the observed density represents the integrated effect of a coherence structure extending across ζ .

Thus:

- orbitals are not primary objects
- they are **projections of resonance configurations**

This interpretation preserves the predictive success of quantum models while providing a physical mechanism underlying their structure.

3.3 Restricted Coherence Modes and Pair Formation

A crucial constraint of the resonance field is that only a limited number of globally stable coherence modes can exist simultaneously within a given region.

In the case of electron-like nodes, this leads naturally to:

- pair formation
- discrete occupancy patterns
- limited spatial configurations

This replaces the need for ad hoc rules governing electron pairing.

Instead, pairing arises as a direct consequence of **coherence stability constraints**.

3.4 Structural Role of Electron Coherence

Because electron-like nodes extend across a larger coherence domain:

- they dominate interaction behavior
- they regulate Field Matrix response
- they determine how coherence redistributes in space

This makes them the primary agents of structure formation.

Atomic cores act as anchors, but the geometry of matter is largely determined by the coherence behavior of electron-like structures.

3.5 From Electron Structure to Molecular Geometry

The transition from electron behavior to molecular structure is therefore direct:

- electron coherence defines allowable configurations
- Field Matrix response generates dual-node structures
- stable configurations emerge as geometric forms

This provides a continuous explanation from:

electron structure → coherence interaction → molecular geometry

4. Coherence-Driven Formation of Molecular and Structural Geometry

4.1 From Electron Coherence to Structure

Classical crystallography has shown that only discrete lattice structures are possible [3], and that these structures are governed by symmetry constraints and interference conditions [2].

The present framework extends this idea by identifying the underlying mechanism as coherence-constrained resonance within the Field Matrix.

Building on the electron coherence framework described in the previous section, the formation of molecular and material structures can be understood as a direct consequence of how electron-like resonance nodes interact with the Field Matrix.

While atomic cores provide stable anchoring points, they do not determine geometry on their own. Instead, structure arises from the behavior of electron coherence and the Field Matrix response it induces.

Electron-like nodes, due to their extended coherence across ζ , generate distributed coherence gradients that cannot be resolved through purely local interactions. The Field Matrix responds by forming stabilized coherence configurations between nodes, resulting in structured spatial arrangements. Thus, molecular geometry is not imposed, but **emerges from coherence equilibrium conditions**.

4.2 Dual-Node Structures as Field Responses

When electron-like nodes interact, the Field Matrix forms **dual-node configurations** to restore coherence balance.

These structures:

- redistribute coherence between nodes
- stabilize relative positioning
- minimize internal coherence tension

Unlike classical bonding models, these dual-node structures are not fixed connections but **dynamic equilibrium configurations of the field**.

Their geometry is determined by the requirement that:

- lateral coherence gradients are minimized
- sequential coherence remains stable
- no internal resonance conflict is introduced

This leads to discrete, stable spatial configurations.

4.3 Origin of Bond Angles and Molecular Geometry

The angular structure of molecules arises naturally from coherence constraints.

Because electron coherence extends across a broader domain:

- interactions are orientation-dependent
- multiple nodes must satisfy coherence simultaneously
- only specific angular configurations remain stable

This could explain:

- fixed bond angles
- discrete molecular geometries
- reproducible structural patterns

Thus, what is traditionally described by orbital hybridization or VSEPR rules corresponds here to **coherence-selected equilibrium states**.

4.4 Discrete Structural Selection

A key consequence of the framework is that structural configurations are **not continuous**.

Instead:

- only certain coherence arrangements are stable
- intermediate configurations collapse into stable states
- geometry is quantized at the structural level

This explains why:

- molecules adopt specific shapes
- crystals form repeating lattices
- structural transitions occur abruptly

Structure is therefore **selected**, not gradually formed.

4.5 Crystal Formation as Coherence Tiling

In extended systems, such as crystalline materials, coherence interactions propagate across many nodes.

The Field Matrix organizes these interactions into repeating structures that:

- maintain global coherence
- minimize cumulative tension
- satisfy local stability constraints

This leads to:

- lattice formation
- symmetry patterns
- periodic structures

Crystals can therefore be understood as **large-scale coherence tilings** of the Field Matrix. This interpretation is further explored in applications to crystalline systems, where lattice symmetries and material responses are analyzed within a resonance-based framework [8].

4.6 Helical Structures and Extended Coherence (DNA Example)

In systems where coherence interactions extend over long ranges, planar or symmetric configurations are no longer sufficient.

Instead, the Field Matrix resolves coherence constraints through **continuous rotational organization**.

This leads to:

- spiral structures
- helical geometries
- phase-aligned rotational patterns

The DNA helix provides a direct and observable example of this mechanism.

Its structure arises because:

- electron coherence extends along the molecular backbone
- phase alignment cannot be maintained in a linear or planar configuration
- a helical arrangement minimizes global coherence tension

Thus, the DNA structure is not an arbitrary biological solution, but a **coherence-optimal configuration** of the Field Matrix. Related applications to biomolecular systems, including protein folding and nucleic acid structure, have been investigated within the same resonance framework, where structural formation is interpreted as rapid convergence toward stable coherence configurations [9].

4.7 Apparent Higher-Dimensional Geometry

The structures described above often exhibit properties that appear higher-dimensional when viewed in three-dimensional space.

This effect arises because:

- electron coherence extends beyond local spatial interaction
- the Field Matrix responds to global coherence constraints
- geometry reflects internal coherence organization

This creates structures that resemble projections of higher-dimensional systems, without requiring additional spatial dimensions.

The crucial missing element in classical descriptions of structure formation is not how interactions occur, but why only specific geometries are realized.

Within the resonance field framework, this follows from the fact that only certain coherence configurations can remain globally stable. These configurations correspond to harmonic solutions of the field, in which phase alignment, coherence distribution, and internal stability are simultaneously satisfied.

As a result, the Field Matrix does not allow arbitrary structural arrangements. Instead, it selects from a discrete set of geometries that satisfy these global coherence conditions.

This explains why specific forms repeatedly emerge in nature:

- tetrahedral configurations arise as the simplest stable arrangement of four coherence directions
- hexagonal symmetry emerges from six-fold phase-balanced resonance structures
- cubic lattices reflect isotropic coherence distribution across orthogonal directions
- helical forms arise when coherence must be preserved under continuous phase progression

Thus, the observed geometries of molecules and crystals are not merely the result of local interactions, but expressions of a discrete set of globally stable harmonic solutions permitted by the Field Matrix.

4.8 Summary of Structural Formation Mechanism

The formation of matter follows a unified mechanism:

- stable nodes act as anchors
- electron coherence extends across the field
- the Field Matrix responds to coherence imbalance
- dual-node structures form as stabilizing elements
- geometry emerges from coherence equilibrium

Thus:

The form of matter is the direct expression of coherence stability within the field.

5. Implications and Applications of Coherence-Based Structure Formation

The coherence-based framework presented in this work provides a unified interpretation of structural formation across multiple domains of physics, chemistry, and biology.

5.1 Molecular Chemistry

Within this framework, molecular geometry is not governed by empirical rules such as orbital hybridization or electron pair repulsion alone, but arises from coherence constraints imposed by the Field Matrix.

This provides a structural interpretation of:

- bond angles
- molecular symmetry
- electron pairing
- orbital-like distributions

Thus, models such as VSEPR and orbital theory can be understood as effective descriptions of underlying coherence-stabilized configurations.

5.2 Crystallography and Materials Science

Crystal structures emerge as large-scale coherence tilings of the Field Matrix.

This explains:

- why specific lattice symmetries repeat
- why transitions between crystal phases can occur abruptly
- why certain structures exhibit exceptional stability

It also provides a deeper interpretation of phenomena such as:

- piezoelectricity
- phase transitions
- structural anisotropy

as responses of the Field Matrix to perturbations in coherence.

5.3 Biological Structure and Self-Assembly

The framework naturally extends to biological systems, where rapid and precise structural formation remains partially unexplained.

Structures such as:

- protein folds
- DNA helices
- recurring biological symmetries

can be interpreted as coherence-driven configurations rather than purely stochastic outcomes.

This offers a possible explanation for:

- the speed of protein folding
- the reproducibility of biological structure
- the emergence of helical and hierarchical organization

5.4 Toward Predictive Structure Design

Because structure is determined by coherence constraints rather than arbitrary interactions, the framework suggests the possibility of predicting and designing structures based on resonance conditions.

This may enable:

- prediction of stable molecular geometries
- design of new crystalline materials
- control of functional material properties
- engineering of self-assembling systems

A useful historical analogy can be drawn from classical gravitational theory. When the laws of gravity were sufficiently understood, they enabled the prediction of previously unknown celestial bodies—most notably the discovery of Neptune through deviations in the orbit of Uranus.

A framework that captures the underlying principles governing structural formation may provide predictive capability beyond currently known configurations. Rather than relying solely on empirical discovery, it may become possible to identify previously unknown stable molecular, crystalline, or material structures by analyzing coherence conditions and resonance constraints within the field.

Such an approach would shift structural science from descriptive classification toward predictive design based on fundamental stability principles.

6. Conclusion

This work has presented a coherence-based framework for understanding the formation of structure in physical systems. By introducing an internal coherence parameter and redefining stability as a global resonance condition, the model provides a unified interpretation of how matter organizes across scales.

While classical crystallography revealed that structure is governed by symmetry and interference, the present framework provides a mechanism by which such constraints arise from coherence stability within the field.

Within this perspective, particles are not primary building blocks, but stable resonance nodes, and structure emerges through the response of the Field Matrix to coherence constraints imposed by these nodes.

This leads to a fundamental shift in interpretation:

- geometry is not imposed by interaction rules
- structure is not the result of arbitrary assembly
- and stability is not purely local

Instead:

The forms observed in nature are the result of coherence-constrained resonance solutions within the field.

Thus, the recurring geometries of molecules, crystals, and biological systems can be understood as expressions of a deeper organizing principle:

Nature's forms are not free—they are solutions to a resonance problem.

This perspective offers a pathway toward a more unified understanding of structure, bridging physics, chemistry, and biology within a single coherence-based framework.

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