Coherence Phase Space: A Structural Classification Framework for Particles in the Mesh Model

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Overview

This document introduces the *Coherence Phase Space* (CPS), a foundational framework for classifying particles within the Mesh Model. Unlike the Standard Model, which organizes particles by symmetry group representations (e.g., SU(3)×SU(2)×U(1)) [1], CPS classifies particles based on their structural behavior within the mesh—specifically their coherence, stability, and geometric interaction. This approach enables a rethinking of particle identity not as intrinsic, but as *emergent from structural resonance*. It is a framework of physics grounded not in symmetry, but in structure.

CPS reflects a broader ambition of the Mesh Model: to reframe how we understand the very architecture of reality. Rather than viewing particles or fields as primary, the Mesh Model proposes a generative cascade:

Structure → **Geometry** → **Fields** → **Particles** → **Our World**

This is not the only possible layering, but it represents a compelling and testable hypothesis grounded in the most fundamental principle the Mesh Model offers: **coherence** [2]. If coherence underpins the stability of all physical phenomena, then CPS may provide the most natural way to classify reality. We may not yet know why this ordering is privileged—but it offers a way forward that is anchored in measurable structure and responsive to future discovery.

Coherence Phase Space as a Map of Structure

The Coherence Phase Space is best understood as a dynamic structural map, not just a classification grid. It does not limit itself to cataloging known particles—it provides a continuous landscape where any coherent structure, whether experimentally confirmed or purely theoretical, can be positioned. By treating each point in CPS as a location in structural possibility space, it becomes a tool for discovery as well as organization [2].

CPS encourages an open-minded approach to physical exploration. It is not a closed model. Instead, it outlines the boundaries of coherence, interaction, and curvature response—helping us understand not only what has been found, but also where new kinds of structures might live. Some domains may turn out to be barren, others rich with possibility. What matters is that we now have coordinates for the search.

Rather than making grand claims, the CPS framework invites modest but powerful shifts in thinking: that particles are not static identities, but dynamic results of structural behavior; that coherence and stability may offer more meaningful insight than symmetry alone; and that the boundaries of the CPS may reflect the true boundaries of creation—not in myth, but in form [3].

Core Dimensions of Coherence Phase Space

Each particle is described by the following key physical characteristics:

Symbol	Name	Description
λ_s	Coherence Scale	Characteristic spatial extent or wavelength of the particle's coherence structure.
τ_s	Coherence Lifetime	Duration for which the particle remains coherent before decohering or decaying.
T_s	Tension Coupling	Tension gradient required to stabilize or sustain the particle structure.
κ_s	Curvature Responsiveness	Sensitivity of the particle to curvature in the mesh; degree to which it warps or reacts to geometric deformation.

These parameters are introduced in the Mesh Model as the defining structural axes for particle identity, replacing symmetry-based labels with physical coherence metrics [2]. While defined at the scalar level here, these quantities remain fully consistent with the covariant, rank-2 tensor framework underlying the quantum-corrected transport geometry of the Mesh Model.

Phase Space Zones

Particles are categorized based on their positions in the CPS:

Zone	Name	Characteristics / Example Particles
I	Stable Cores	Long coherence time, low coherence scale; highly localized and persistent (e.g., electron, proton)
II	Meta-Stable Modes	Moderate stability and coherence range (e.g., muon, neutron)
III	Resonant Structures	Short-lived excitations, typically large in λ_s; rapidly decohering (e.g., pions, heavy mesons)
IV	Curvature-Resonant States	Highly geometry-sensitive structures; massless or near-massless; encode spacetime information (e.g., graviton analogs, coherence shells) [4]
V	Nonlinear Soliton States	Topologically stable, self-reinforcing modes within the mesh; candidates for dark matter or exotic composite states [5]
VI	Curvature Substrate	Non-excitatory mesh structure; infinite coherence, no decay, no identity; possible home of dark energy and inflation field behavior [6]

This zoning framework reflects structural behaviors introduced in the Mesh Model, and helps categorize known particles as well as potential new coherence-based states [2].

Directional Coherence and Curvature Inversion

All currently known particles exhibit attractive gravitational behavior. To remain aligned with this observation, the Mesh Model defines coherence fields as *direction-neutral* by design. Specifically, the activation of curvature in the Lagrangian is structured as an absolute-value threshold, ensuring that only coherence magnitude—not direction—affects curvature [3].

However, if future experiments were to uncover a particle exhibiting anti-gravitational behavior or negative curvature influence, such a discovery would imply that *coherence may be direction-sensitive*. The CPS framework is intentionally extensible to such a case. In this scenario, anti-coherent particles would occupy a mirrored region of CPS, characterized by negative curvature responsiveness $\kappa_s < 0$. The Mesh Model's Lagrangian could then be modified by relaxing or removing the absolute value constraint, introducing signed curvature contributions without disrupting the existing model.

In short, while coherence is currently treated as direction-neutral, this is an intentional restriction to match experimental observations. If nature reveals a direction-dependent coherence signature, the model and CPS are both designed to adapt.

Structural Interpretation vs. Standard Model

Aspect	**Standard Model (Symmetry Lens)**	**Mesh Model (Structure Lens)**
Classification	By spin, statistics, group representation [1]	By stability, coherence scale, curvature sensitivity [2]
Mass Origin	Higgs field coupling [7]	Standing wave resonance in curvature-tension field [2]
Decay	Quantum transition probabilities	Coherence failure due to structural instability [3]
Interaction	Gauge boson exchange	Tension redistribution, curvature deflection [2]
Identity	Particle = representation of symmetry	Particle = stable coherent structure in the mesh [2]

Outlook

The Coherence Phase Space (CPS) lays the foundation for a new form of field theory: one in which the behavior, identity, and interaction of particles is mapped through mesh-level structure. It provides a physically intuitive lens for reinterpreting existing particles and predicting new ones—not through symmetry, but through stability.

Future work will involve:

- Mapping known particles explicitly into CPS
- Simulating transitions between coherence zones
- Predicting novel structures based on unexplored CPS regions
- Building a structural QFT rooted in CPS principles [2]

This approach enables a reintegration of particle physics with the underlying structure of space-time, and represents a break from the symmetry-first mindset that has dominated since the 20th century [1]. CPS is the Mesh Model's natural lens for understanding what particles *are*.

Appendix: Coherence Behavior Table (Full Particle Spectrum)

The following table shows structural coherence parameters for a comprehensive list of known, predicted, and dark sector particles. The composite Z-axis score is defined as:

$$Z = \text{Decay} \times (1 + \text{Spin} + |\text{Charge}|)$$

This score reflects the particle's structural complexity in terms of decay pathways, coherence asymmetry, and angular momentum. The Z-score is not derived from quantum numbers or symmetry operations, but from coherence-based structure — a redefinition proposed in the Mesh Model framework [2].

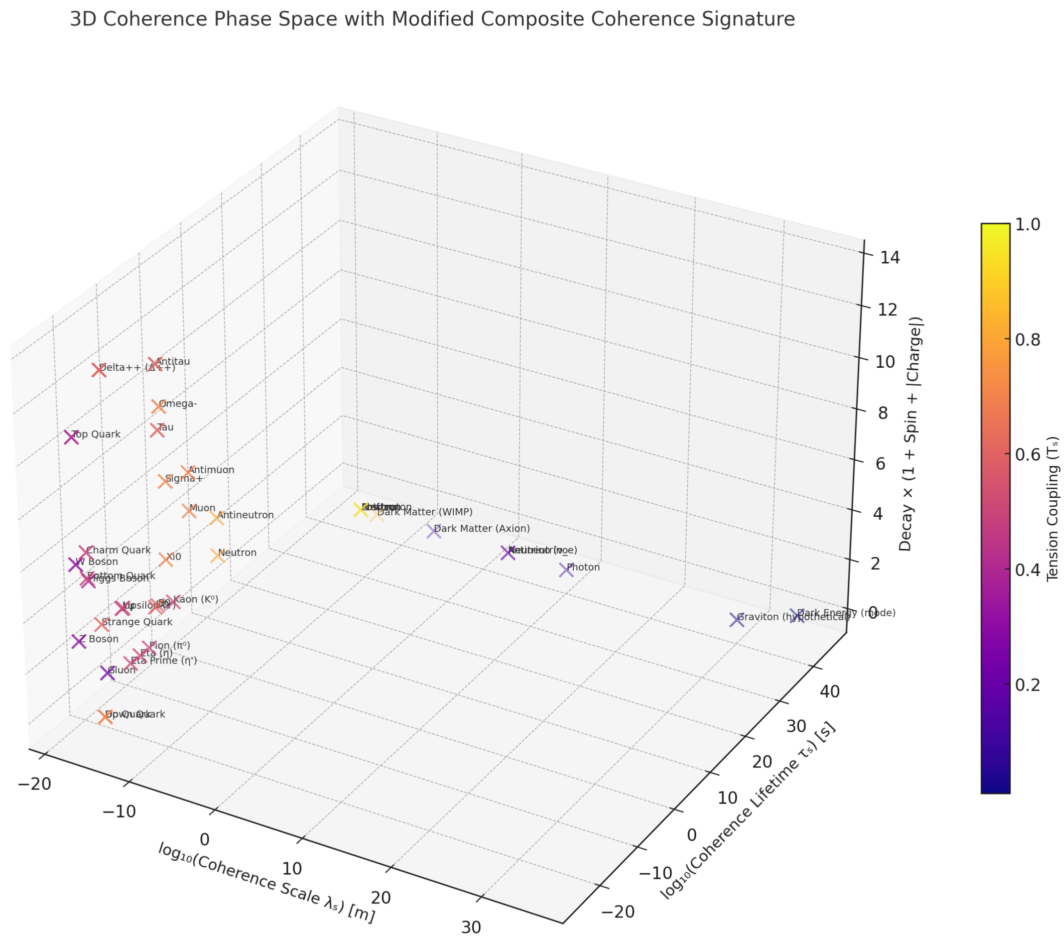

Figure 1: 3D Coherence Phase Space with Modified Composite Coherence Signature. Each particle is positioned by coherence scale (λ_s), coherence lifetime (τ_s), and structural complexity $Z = \text{Decay} \times (1 + \text{Spin} + |\text{Charge}|)$. Color encodes the tension coupling parameter T_s. Unlike symmetry-based diagrams of the Standard Model [1], this representation emphasizes persistence and coherence structure [2].

Name	$\log_{10}(\lambda_s)$	$\log_{10}(\tau_s)$	T_s	Spin	Charge (e)	Decay	Z
Tau	-14.0	-12.54	0.6	0.5	-1	5	12.5
Muon	-14.0	-5.66	0.7	0.5	-1	3	7.5
Neutron	-15.0	2.94	0.8	0.5	0	3	4.5
Electron	-15.0	40.0	0.9	0.5	-1	0	0.0

Name	$\log_{10}(\lambda_s)$	$\log_{10}(\tau_s)$	T_s	Spin	Charge (e)	Decay	Z
Proton	-15.0	40.0	1.0	0.5	1	0	0.0
Positron	-15.0	40.0	0.9	0.5	1	0	0.0
Antiproton	-15.0	40.0	1.0	0.5	-1	0	0.0
Antineutron	-15.0	40.0	0.8	0.5	0	3	4.5
Antimuon	-14.0	-5.66	0.7	0.5	1	3	7.5
Antitau	-14.0	-12.54	0.6	0.5	1	5	12.5
Antineutrino	-15.0	40.0	0.2	0.5	0	0	0.0
W Boson	-14.0	-5.00	0.7	1.0	1	3	9.0
Z Boson	-15.0	-8.94	0.6	1.0	0	2	4.0
Higgs Boson	-15.0	-8.94	0.6	0.0	0	2	2.0
Gluon	-15.0	-8.94	0.4	1.0	0	2	4.0
Photon	-15.0	40.0	0.1	1.0	0	0	0.0
Neutrino	-15.0	40.0	0.2	0.5	0	0	0.0
Dark Matter (WIMP)	-13.0	40.0	0.85	0.5	0	0	0.0
Dark Matter (Axion)	-12.0	40.0	0.4	0.0	0	0	0.0
Dark Energy (mode)	-6.0	40.0	0.01	0.0	0	0	0.0
Up Quark	-19.0	-20.0	0.4	0.5	0.67	3	7.0
Down Quark	-19.0	-20.0	0.4	0.5	-0.33	3	6.0
Strange Quark	-18.0	-18.0	0.5	0.5	-0.33	3	6.0
Charm Quark	-18.0	-17.0	0.5	0.5	0.67	3	7.0
Bottom Quark	-18.0	-17.0	0.5	0.5	-0.33	3	6.0
Top Quark	-17.0	-25.0	0.6	0.5	0.67	3	7.0
Pion (π^+)	-17.0	-12.0	0.4	0.0	1	2	4.0
Kaon (K^+)	-17.0	-10.5	0.4	0.0	1	2	4.0
Xi^0	-16.0	-6.0	0.6	0.5	0	2	3.0
Xi^-	-16.0	-6.0	0.6	0.5	-1	2	6.0
Sigma^+	-16.5	-5.0	0.7	0.5	1	2	6.0
Sigma^-	-16.5	-5.0	0.7	0.5	-1	2	6.0
Delta^+	-16.0	-7.0	0.7	1.5	1	2	10.0
Omega^-	-16.0	-6.5	0.7	1.5	-1	2	10.0
Graviton (hyp.)	-15.0	40.0	0.2	2.0	0	0	0.0
Neutrino (ν_e)	-15.0	40.0	0.2	0.5	0	0	0.0
Neutrino (ν_μ)	-15.0	40.0	0.2	0.5	0	0	0.0
Neutrino (ν_τ)	-15.0	40.0	0.2	0.5	0	0	0.0

Structural Persistence and Coherence Dominance

While the Z-score captures a particle's structural complexity (decay $\times$ spin $\times$ charge asymmetry), it does not reflect its stability. To evaluate persistence, the Coherence Phase Space naturally suggests another structural quantity:

$$\textbf{Persistence Ratio} \quad \mathcal{P} = \frac{\tau_s}{T_s}$$

Where: - τ_s is the coherence lifetime (in seconds) - T_s is the tension coupling (unitless gradient) - $\mathcal{P}$ is a dimensionless measure of how much "time per tension" a structure persists

This ratio is introduced as part of the structural coherence approach outlined in the Mesh Model [2], and serves as a complementary diagnostic to traditional decay-based classification in the Standard Model [1].

Particles with high persistence ratios are structurally dominant — not because they act, but because they endure. Below is a ranking of key particles by their estimated log-scale persistence, including both familiar particles and candidates from the dark sector.

Particle	$\log_{10}(\tau_s)$	T_s	$\log_{10}(\mathcal{P})$
Dark Energy (mode)	40.0	0.01	42.0
Axion (Dark Matter)	40.0	0.4	39.4
Photon	40.0	0.1	40.0
Neutrino	40.0	0.2	39.7
Electron	40.0	0.9	39.0
Proton	40.0	1.0	40.0
Antineutron	40.0	0.8	40.1
Neutron	2.94	0.8	3.04
Muon	-5.66	0.7	-5.5
Tau	-12.54	0.6	-12.3
W Boson	-5.00	0.7	-4.9
Z Boson	-8.94	0.6	-8.7
Top Quark	-25.0	0.6	-24.8
Up/Down Quark (free)	-20.0	0.4	-19.4

These values suggest a powerful structural observation: the most abundant or influential components of the universe may not be those with the most energy, but those with the greatest persistence. CPS highlights that dark energy and dark matter are not strange outliers — they are structurally optimal at persisting. Their universality may reflect not interaction strength, but coherence efficiency [2].

This coherence-first perspective reframes why the universe is filled with what it is: not due to symmetry or interaction rules, but because **structure survives when it requires very little to do so**.

Interpretation of Dark Sector Placement

The Coherence Phase Space framework not only classifies known particles structurally, but also offers a potential interpretation of the dark sector. When viewed through coherence behavior and structural placement, dark matter and dark energy may represent not anomalies, but expected features of the mesh model's architecture [2].

- **Dark Matter** appears naturally in Zone V (Nonlinear Soliton States), a region occupied by topologically stable, long-lived coherence structures that couple weakly to curvature. These may persist over cosmic time without decay, consistent with dark matter's non-luminous, gravitationally influential role. Their structural stability — rather than energetic abundance — may explain why dark matter accounts for approximately 27% of the universe's total energy content [6].

- **Dark Energy** aligns with Zone VI (Curvature Substrate), the most stable and non-interacting region of CPS. This zone represents the undeformed state of the mesh: a background coherence field with near-infinite lifetime and minimal curvature response. If dark energy reflects this structural baseline, its dominance in the universe (68% of energy density) may not imply activity, but omnipresence [6]. It is not a thing, but the absence of deformation — a persistent, low-tension ground state.

These interpretations are not definitive. Other mechanisms or frameworks may yet emerge to explain the nature and behavior of dark matter and dark energy more completely. However, CPS provides a compelling structural rationale for their roles: not as exotic additions, but as natural inhabitants of the coherence landscape. Their abundance may be a reflection not of interaction strength, but of structural persistence.

References

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