Replacing Parameters with Physical Necessity: Quarkbase Cosmology

Carlos Omeñaca Prado

December 2025

Abstract

Modern fundamental physics achieves extraordinary predictive success while failing to provide a unified physical explanation for several structural facts of nature: the coexistence of reversible and irreversible phenomena, the discrete and finite hierarchy of elementary excitations, absolute confinement, matter–antimatter asymmetry, and the emergence of large-scale cosmic order. These problems are traditionally treated as independent anomalies, addressed by unrelated mechanisms and additional parameters.

This work presents **Quarkbase Cosmology**, a framework that replaces parameter-based explanations with physical necessity. The theory is grounded on a minimal ontological postulate: the physical vacuum is a continuous, non-dissipative pressure medium described by a scalar field Ψ. All physical structures arise from discrete compactations of this medium (quarkbases), and all interactions emerge as responses to pressure gradients within it.

From this single substrate, the framework derives: conditional irreversibility via vacuum recomposition; neutrino oscillations without intrinsic neutrino masses; the charged-lepton spectrum as resonant modes of a finite compactation; color confinement as a geometric consequence of topological continuity; matter–antimatter asymmetry as phase-orientation selection rather than CP-driven baryogenesis; and cosmic large-scale structure as anisotropic instability of the Ψ-field, without invoking dark matter. Standard force laws and interaction potentials arise as effective limits of a small set of field relations, including a Yukawa-type stationary solution that reflects medium screening rather than particle mediation.

The theory makes explicit, non-adjustable exclusions and is therefore falsifiable. If any of the above phenomena are shown to originate from independent ontologies or require fundamentally unrelated mechanisms, the framework is wrong. If correct, Quarkbase Cosmology implies that much of the current theoretical scaffolding is not incomplete but conceptually misplaced.

Contents

1 Foundational axioms and minimal formulation of Quarkbase Cosmology

Quarkbase Cosmology is not constructed by extending existing theories or introducing additional interaction sectors. It begins from a minimal set of ontological commitments concerning the physical nature of the vacuum and the origin of structure. From these commitments, particles, forces, irreversibility, and cosmology emerge as necessary consequences.

This section states explicitly the axioms and the minimal mathematical relations from which the rest of the framework follows. These relations coincide with the foundational formulation presented in the Quarkbase Cosmology repository.

1.1 Axiom I The vacuum is a physical medium

The physical vacuum is not empty space. It is a continuous physical medium characterized by a real scalar pressure field

$$\Psi = \Psi(x, t),$$

which represents the local pressure density of an etheric plasma.

This medium is continuous, non-granular, and capable of sustaining stable pressure gradients, filamentary structures, and long-range correlations. It possesses zero intrinsic dissipation, so pressure gradients do not decay spontaneously. Any deformation of the medium must propagate, reorganize, or remain stationary.

The Ψ-field is the sole ontological substrate of the theory.

1.2 Axiom II Structure arises through volume displacement

The only elementary structural entities admitted by the theory are *quarkbases*: compact regions of displaced Ψ-medium volume.

A quarkbase excludes a finite volume of the medium and introduces a geometric discontinuity. It carries no intrinsic mass, charge, or interaction labels. Because the total volume of the Ψ-medium is conserved, any local displacement necessarily generates compensating pressure gradients in the surrounding field.

All physical structure arises from the geometry and organization of these displaced volumes.

1.3 Axiom III Interactions are pressure-gradient responses

There are no fundamental forces in Quarkbase Cosmology. What are conventionally identified as forces emerge as responses of the medium to pressure gradients generated by displaced volume.

The fundamental interaction law is

$$\mathbf{F} \propto -\nabla\Psi.$$

Gravitation, electromagnetism, and nuclear interactions correspond to different geometric and dynamical regimes of this same pressure-gradient response.

1.4 Axiom IV Stability requires stationary configurations

A physical structure is stable if and only if it admits a stationary configuration of the pressure field,

$$\frac{\partial \Psi}{\partial t} = 0,$$

within its domain.

Only discrete geometric compactations satisfy this condition. Continuous or arbitrary configurations are forbidden by the medium itself. This axiom is the origin of quantization, hierarchy, and the finiteness of particle families.

1.5 Axiom V Phase structure determines physical identity

The Ψ-medium supports oscillatory modes. When quarkbases induce vibration, physical identity is determined by phase structure rather than by intrinsic labels.

Neutrinos correspond to phase-dominated minimal compactations, charged particles to stable phase asymmetries, and antimatter to inverted phase orientation. Phase orientation is selected by global field evolution; symmetry between phases is not assumed.

1.6 Axiom VI Irreversibility from structural non-invertibility

Although the local dynamics of the Ψ-medium are reversible, not all structural transitions are invertible. When a compactation crosses a structural threshold, the global field recomposes such that

$$\Psi_{\text{before}} \not\leftrightarrow \Psi_{\text{after}}.$$

Irreversibility therefore arises from geometry rather than statistics. The arrow of time is a physical boundary between structurally distinct regimes.

1.7 Minimal mathematical formulation

At the level of effective description, the entire framework is generated from the following four fundamental relations:

(1) Pressure field

$$\Psi = \Psi(x, t)$$

(2) Fundamental interaction law

$$\mathbf{F} \propto -\nabla \Psi$$

(3) Pressure-wave dynamics

$$\frac{\partial^2 \Psi}{\partial t^2} = c_\Psi^2 \nabla^2 \Psi$$

where c_Ψ is the characteristic propagation speed of pressure waves in the medium.

(4) Elementary quarkbase solution The stationary pressure potential generated by an isolated quarkbase admits a Yukawa-type form,

$$\Psi(r) = \Psi_0 \frac{e^{-r/\lambda}}{r},$$

where λ is the screening length of the medium and Ψ_0 sets the compactation strength.

All familiar force laws arise as limiting regimes or effective descriptions of these relations under specific geometric and boundary conditions.

1.8 Consequence

From these axioms and relations alone follow the emergence of forces without force postulates, particle spectra without free parameters, confinement without mediation, matter–antimatter asymmetry without symmetry breaking, cosmic structure without dark matter, and irreversibility without statistical assumptions.

Nothing else is assumed.

2 The criterion the Standard Model does not meet

2.1 What a fundamental physical theory must explain

A theory that claims fundamental status must satisfy a minimal physical criterion: it must explain *why* the observed structures and regularities of nature exist, not merely reproduce them mathematically. In particular, such a theory must account—**within a single physical framework**—for:

- the coexistence of reversible and irreversible phenomena,
- the discrete and finite hierarchy of elementary excitations,
- the absolute stability and confinement of composite structures,
- the emergence of large-scale cosmic order from microscopic dynamics.

These are not optional features or "open problems." They are **structural facts of reality**. A theory that requires separate principles, unrelated mechanisms, or auxiliary assumptions for each of them is, by definition, not fundamental.

This criterion is not philosophical. It is operational. Any framework that claims fundamentality must explain, from the same physical ontology, why

$$\text{micro-dynamics are reversible} \quad \text{while} \quad \text{macro-dynamics are not},$$

why only a **finite number of stable excitations** exist, and why structure persists across more than thirty orders of magnitude in scale.

In Quarkbase Cosmology, this criterion is taken as primary and is addressed explicitly in:

- *Genesis Quarkbase*,

- *General Cosmology of Quarkbase (Neutrino)*,
- and the dedicated analysis of time irreversibility in *Conditional Irreversibility and the Emergence of the Time Arrow from Vacuum Recomposition* (2025).

Mathematical consistency and empirical agreement are necessary conditions, but they are not sufficient. A parameterized fit to data is not an explanation unless the parameters themselves emerge from the same physical ontology as the phenomena they describe.

2.2 Empirical success versus ontological failure

The Standard Model excels at prediction within its operational domain. Cross sections, decay rates, and scattering amplitudes are computed with extraordinary precision. However, this success masks a deeper failure: **the absence of a unified physical substrate from which its elements arise**.

Key features of the Standard Model are not derived but *assumed*:

- particle masses are inserted through Yukawa couplings,

  $$\mathcal{L}_Y = y_f \, \bar{\psi}_f \, \phi \, \psi_f,$$

  where the coupling constants y_f are free parameters with no physical origin;

- neutrino oscillations require postulated mass splittings,

  $$P_{\alpha\to\beta}(L) \sim \sin^2\!\left(\frac{\Delta m^2 \, L}{4E}\right),$$

  even though no experiment directly measures intrinsic neutrino mass (see *Neutrino Oscillations as Internal Mode Interference in the Vacuum Pressure Field*, 2025);

- color confinement is established numerically but lacks analytic inevitability, as explicitly acknowledged in the QCD literature and addressed geometrically in *Color Confinement — The Unresolved Structural Anomaly of QCD* (2025);
- the arrow of time is relegated to statistical interpretation rather than physical cause, despite the exact time-reversal symmetry of the fundamental equations.

Each of these gaps is treated as an independent issue. In reality, they all stem from the same omission: **the theory contains interactions, symmetries, and fields, but no physical medium and no criterion for structural emergence**.

By contrast, Quarkbase Cosmology introduces a single physical substrate—the Ψ-field—and a single elementary compactation ($N = 1$), from which these phenomena arise as different regimes of the same dynamics.

The result is not an extension of the Standard Model, but a reinterpretation of its successful equations as *effective limits* of a deeper physical structure.

2.3 Why adding parameters is not explanation

When confronted with discrepancies, the Standard Model responds by extension: new fields, new particles, new symmetry breakings, new sectors. This strategy preserves calculational power but postpones physical understanding.

Introducing additional parameters does not resolve a conceptual problem; it only redistributes it. A mass term without a physical origin is not explained by assigning it a smaller value. A hierarchy is not explained by fitting it. A phenomenon is not understood because it is reproducible within a formalism.

From a physical standpoint, the following pattern is diagnostic:

$$\text{More parameters} \quad \Rightarrow \quad \text{less ontology.}$$

In Quarkbase Cosmology, the direction is reversed. The number of free assumptions is reduced to one ontological postulate, and structural features follow as necessary consequences. This includes:

- conditional irreversibility from vacuum recomposition,
- discrete spectra from resonant compactations ($N = 1, 13, 55, \ldots$),
- confinement as topological continuity,
- cosmic structure as Ψ-field self-organization.

These results are developed across the published corpus, including:

- *The Leptonic Spectrum of the Ψ-Field* (2025),
- *Law of Antimatter Emergence in Quarkbase Cosmology* (2025),
- *Filamentation and Supercluster Formation in a Three-Phase Etheric Plasma* (2025).

The persistence of irreversibility, hierarchy, confinement, and cosmic structure as separate unresolved problems indicates that the issue is not technical but foundational. The Standard Model does not fail because it is wrong in its predictions; it fails because it does not answer the kind of questions a **fundamental physical theory** must answer.

This work starts from that diagnosis.

3 A single diagnosis, not many anomalies

3.1 The false independence of modern "open problems"

Modern fundamental physics presents its unresolved issues as a collection of loosely related anomalies: the origin of neutrino masses, the hierarchy of fermion masses, the mechanism of confinement, the arrow of time, the nature of dark matter, the cause of cosmic structure formation. Each is assigned to a different subfield, with its own technical language, approximations, and specialized fixes.

This fragmentation is **not empirical**. It is **institutional**.

There is no experiment that indicates that the physical origin of time irreversibility is independent from the origin of mass, or that confinement belongs to a different ontological category than particle hierarchies. The separation arises from treating mathematical formalisms as primary and physical ontology as secondary.

As a consequence, one accepts without tension that:

- time irreversibility is "explained" statistically,
- mass arises from spontaneous symmetry breaking,
- confinement is delegated to numerical lattice evidence,
- cosmic structure requires inflation plus dark matter,
- neutrino behavior demands independent mass sectors.

Each solution works locally. None of them speak to each other.

This compartmentalization is explicitly challenged in the Quarkbase corpus, beginning with *Genesis Quarkbase* and systematized in *General Cosmology of Quarkbase (Neutrino)*, where all these phenomena are treated as manifestations of a single physical medium.

Once fragmentation is accepted, coherence is no longer required. One can invoke:

- entropy and coarse-graining for time,
- Yukawa tuning for hierarchy,
- gauge confinement for hadrons,
- inflation for homogeneity,
- invisible matter for structure formation,

without ever asking whether these mechanisms are compatible or even belong to the same physical reality.

3.2 Why time, hierarchy, confinement, and cosmology are the same problem

At a structural level, these phenomena share a defining feature: they all involve the emergence of **stable, directed, or discrete structures** from an underlying substrate.

- **Irreversibility** reflects a transition between regimes where dynamics are invertible and regimes where they are not.
- **Mass and hierarchy** reflect the existence of discrete energy scales instead of a continuum.
- **Confinement** reflects absolute stability boundaries that cannot be crossed by any finite excitation.
- **Cosmic structure** reflects long-range organization arising without fine-tuned initial conditions.

These are not separate questions. They are the *same question* asked at different scales.

Formally, each problem asks why a system governed by locally reversible equations,

$$\mathcal{L}(\Psi) \quad \text{or} \quad \hat{H}\psi = i\hbar\,\partial_t\psi,$$

produces outcomes that are

$$\text{directional}, \quad \text{discrete}, \quad \text{stable}, \quad \text{hierarchically ordered}.$$

In a truly fundamental theory, these properties must arise from the same physical principle. If they do not, then either nature is incoherent, or the theory describing it is incomplete.

The Standard Model implicitly assumes incoherence and manages it pragmatically. Quarkbase Cosmology takes the opposite stance: **their coexistence is the primary clue**.

This unification is not asserted abstractly; it is demonstrated case by case in:

- *Conditional Irreversibility and the Emergence of the Time Arrow from Vacuum Recomposition* (2025),
- *The Leptonic Spectrum of the* Ψ*-Field* (2025),
- *Color Confinement — The Unresolved Structural Anomaly of QCD* (2025),
- *Filamentation and Supercluster Formation in a Three-Phase Etheric Plasma* (2025).

3.3 The cost of abandoning physical ontology

By refusing to commit to a concrete physical substrate, modern theory has gained flexibility at the expense of necessity. Without a medium, anything can be postulated and nothing is enforced.

This has precise consequences:

- There is no physical criterion separating reversible from irreversible regimes.
- There is no reason for the number of particle families to be finite.
- There is no analytic necessity for confinement.
- There is no mechanism selecting filamentary cosmic structures over alternatives.

What replaces ontology is bookkeeping: parameters, sectors, matrices, and effective descriptions.

This is why the Standard Model contains

$$\text{dozens of free parameters } \{m_f,\, y_f,\, \theta_{ij},\, \Lambda,\, \ldots\},$$

none of which are fixed by the theory itself.

Quarkbase Cosmology begins from a different premise: that these failures are not independent gaps, but **symptoms of a single missing element**—the absence of a real physical medium capable of sustaining structure.

4 Ontological minimalism: the Quarkbase postulate

4.1 The necessity of a physical substrate

Every physical theory, implicitly or explicitly, assumes *something that exists.* When that assumption is left undefined, the theory becomes a collection of rules without a referent. The Standard Model avoids this question by treating fields as abstract entities defined exclusively through symmetry groups and interaction terms. This strategy is mathematically efficient, but physically incomplete.

A fundamental theory cannot remain agnostic about what the universe is made of.

Quarkbase Cosmology begins from the minimal ontological requirement that makes explanation possible at all: the existence of a **single, continuous physical medium** capable of sustaining deformation, propagation, and stable structure. This medium is denoted the **Ψ-field**.

The Ψ-field is not:

- a mathematical trick,
- an auxiliary degree of freedom,
- a reinterpretation of existing gauge fields.

It is the **physical substrate itself**, introduced explicitly and without redundancy. No additional ontological layers are added.

This starting point is developed in full detail in *Genesis Quarkbase* and formalized in *General Cosmology of Quarkbase (Neutrino)* (2025). Here, only the minimal commitments required for confrontation are retained.

4.2 Properties of the Ψ-field

The Ψ-field is characterized by three essential properties. Each is not an assumption chosen to fit observations, but a **necessary condition** for the existence of stable physics.

1. **Continuity**

   The Ψ-field has no intrinsic granularity. It is not composed of discrete elements. Discreteness arises only through *compactations* within the field, not from the field itself. This immediately excludes fundamental point particles as ontological primitives.

2. **Zero intrinsic dissipation**

   The Ψ-field is frictionless. Any perturbation propagates without decay unless a structural reconfiguration occurs. Formally,

   $$\mu_\Psi = 0,$$

   where μ_Ψ denotes intrinsic dissipation. This property is required for:

   - long-range coherence,
   - stable resonant modes,

- persistence of phase information across macroscopic and cosmological scales.

3. **Elastic response to displaced volume**

   Any exclusion of Ψ-field volume generates pressure gradients. These gradients are the sole physical origin of what later appears phenomenologically as force, inertia, and interaction. Schematically,

$$\mathbf{F} \propto -\nabla\Psi,$$

   where Ψ encodes the local deformation state of the medium.

Without these three properties simultaneously, neither particles, nor waves, nor stable structures could exist in any persistent form.

4.3 The only elementary entity: $N = 1$

Within a continuous medium, the most elementary possible physical object is a **minimal compactation**: a localized exclusion of volume that cannot be decomposed further without destroying continuity. This object is denoted $N = 1$.

Empirically, this compactation corresponds to what is observed as the **free neutrino**.

This identification is not semantic or interpretative. It follows from necessity and is argued in detail in *General Cosmology of Quarkbase (Neutrino)* (2025) and *Neutrino Oscillations as Internal Mode Interference in the Vacuum Pressure Field* (2025).

The $N = 1$ compactation satisfies all required conditions:

- it carries no electric charge,
- it is absolutely stable,
- it propagates over cosmological distances with minimal interaction,
- it functions as a carrier of phase rather than as a localized inertial object.

In Quarkbase Cosmology, the neutrino is not one particle among many. It is the **only truly elementary excitation** of the Ψ-field. All higher structures—electrons, protons, nuclei, and beyond—are organized assemblies of $N = 1$ units.

This immediately eliminates the need for a zoo of elementary particles.

4.4 What is *not* assumed

The explanatory power of the framework lies as much in what it excludes as in what it introduces. From the outset, Quarkbase Cosmology does **not** assume:

- intrinsic particle masses as fundamental properties,
- independent gauge fields as ontological entities,
- spontaneous symmetry breaking as a physical mechanism,
- multiple elementary particle species,
- pre-existing spacetime curvature as physical substance.

Instead, standard equations appear as *effective limits.* Schrödinger, Dirac, Maxwell, and relativistic dynamics emerge as approximations describing specific regimes of Ψ-field behavior:

$$\text{Standard equation} \quad \Rightarrow \quad \text{effective } \Psi\text{-field description.}$$

They are recovered, not postulated.

This distinction is essential: the theory does not extend existing formalisms; it **regrounds them physically**.

4.5 Consequence: explanation replaces classification

Once a single physical substrate and a single elementary entity are accepted, several long-standing mysteries immediately lose their independent status.

- Mass hierarchies become resonant structures of compactations.
- Confinement becomes a geometric necessity of continuity.
- Irreversibility becomes a physical transition associated with structural recomposition.
- Cosmic structure becomes a large-scale instability of the same medium.

Problems cease to be classified separately and begin to be **explained together**.

With the ontological foundation established, the framework turns to the most conceptually loaded of these phenomena: the arrow of time—addressed next not as an emergent illusion, but as a real physical effect arising from vacuum dynamics.

5 Conditional irreversibility and the physical origin of time

5.1 Why microscopic reversibility is real

At microscopic scales, physical processes display reversibility with extraordinary precision. Interference fringes can be reconstructed, coherent oscillations can be phase-reversed, and bound configurations can be driven back to their initial states without residual effects. This is not an approximation; it is an experimental fact observed across quantum optics, atomic physics, and condensed matter systems.

Any fundamental theory must therefore preserve microscopic reversibility as a **genuine physical property**, not as a limiting case or a mathematical artifact. Approaches that attempt to break time symmetry at the fundamental level immediately contradict this empirical reality.

Quarkbase Cosmology preserves microscopic reversibility by construction. The Ψ-field is frictionless and its local dynamics are time-symmetric. Formally,

$$\mu_\Psi = 0 \quad \Rightarrow \quad \mathcal{D}_t\Psi = \mathcal{D}_{-t}\Psi,$$

where μ_Ψ denotes intrinsic dissipation and $\mathcal{D}_t$ the local evolution operator. No arrow of time is inserted at the level of equations.

This preservation is not optional; it is required.

5.2 Why macroscopic irreversibility is also real

At macroscopic scales, irreversibility is equally undeniable. Thermal relaxation, diffusion, fracture, chemical reactions, and biological aging proceed in one temporal direction only. These processes are not merely unlikely to reverse; they are **physically inaccessible** to reversal.

Macroscopic irreversibility defines causality, memory, and the operational meaning of time. A theory that explains it away as subjective or statistical does not explain it at all.

Standard physics resolves this tension by appeal to probability: irreversibility is said to emerge from coarse-graining over many degrees of freedom. This explanation is incomplete. Statistics can quantify likelihood; they cannot define physical impossibility.

A low probability is not a prohibition.

A fundamental theory must therefore identify a **physical criterion** that separates reversible from irreversible regimes without violating microscopic reversibility.

5.3 The failure of statistical explanations

Statistical mechanics begins by assuming a distinction between microstates and macrostates. The arrow of time is then derived from the combinatorics of state counting and expressed through entropy increase,

$$\Delta S \geq 0.$$

This framework explains *why entropy tends to increase*, but it does not explain *why entropy-decreasing processes are physically forbidden*. In principle, if all microstates are dynamically reversible, macroscopic reversal should remain possible, however improbable.

In practice, it is not.

Real systems cross thresholds beyond which reversal is not merely unlikely but **undefined**. After fracture, recombination is not a matter of probability. After thermalization, phase coherence is not recoverable by any physical operation. These facts signal a missing ingredient in the statistical picture.

This gap is analyzed explicitly in *Conditional Irreversibility and the Emergence of the Time Arrow from Vacuum Recomposition*.

5.4 Vacuum recomposition as the missing mechanism

In Quarkbase Cosmology, irreversibility arises when a process triggers a **topological reconfiguration of the Ψ-field**. As long as a system evolves within a fixed compactation structure—i.e., with a fixed set of N units—dynamics remain reversible.

Irreversibility appears when a transition **changes the compactation pattern itself**, by:

- creating new $N = 1$ units,
- annihilating existing ones,
- or reorganizing them across structural thresholds.

At that point, the Ψ-field must undergo **global recomposition**.

This recomposition is not dissipative. Energy is conserved. Local equations remain time-symmetric. However, the process is **non-invertible**:

$$\Psi_{\text{before}} \not\leftrightarrow \Psi_{\text{after}}.$$

The field relaxes into a new stationary configuration that does not admit a one-to-one mapping back to the previous one. Phase information is not destroyed locally; it is redistributed globally in a way that cannot be uniquely reversed.

Irreversibility therefore appears **conditionally**:

- reversible within a given structural regime,
- irreversible across structural recomposition.

This mechanism satisfies all empirical constraints without modifying fundamental dynamics or invoking stochastic postulates.

5.5 The arrow of time as a physical boundary, not a convention

In this framework, the arrow of time is neither an emergent illusion nor a bookkeeping convention. It is a **physical boundary** separating regimes of fixed compactation from regimes of vacuum recomposition.

This single criterion explains simultaneously:

- why microscopic processes are reversible,
- why macroscopic processes are irreversible,
- why no fundamental equation violates time symmetry,
- why entropy increase is observed without being fundamental.

Times arrow is not imposed on the laws of physics. It emerges from the **geometry and topology of the Ψ-field** when structural thresholds are crossed.

This interpretation is developed in detail in the Quarkbase analysis of time irreversibility and integrated consistently with particle, nuclear, and cosmological phenomena.

5.6 Structural continuity with the rest of the framework

The mechanism responsible for time irreversibility reappears throughout the theory under different physical manifestations:

- as confinement in hadronic structures,
- as stability thresholds in leptonic hierarchies,
- as matter–antimatter selection,
- as large-scale cosmic ordering.

In all cases, the decisive factor is the existence—or absence—of allowed structural recomposition paths within the Ψ-field.

Time irreversibility is not a special problem. It is the **first observable consequence** of the same ontology that governs particles and cosmology.

With the arrow of time grounded physically, the framework turns next to one of the most experimentally precise and conceptually loaded phenomena in modern physics: neutrino oscillations, reinterpreted without invoking intrinsic neutrino masses.

6 Neutrino oscillations without neutrino masses

6.1 What experiments actually measure

Neutrino oscillation experiments establish a set of robust empirical facts: detection probabilities vary periodically with propagation distance and energy; at least two independent oscillation scales are required; coherence is preserved over macroscopic and even astronomical distances; and oscillation patterns are modified by the medium through which neutrinos propagate. None of these observations directly measures an intrinsic neutrino mass.

What is measured is **phase-dependent interference**.

Experimentally, one reconstructs probabilities of the form

$$P_{\alpha\to\beta}(L,E) = \left| \sum_k A_{\alpha k} A^*_{\beta k} \, e^{i\phi_k(L,E)} \right|^2 ,$$

where only **relative phases** ($\Delta\phi_k$) are observable. The conventional interpretation maps these phases to mass splittings (Δm^2), but this mapping is not forced by the data; it is an interpretive choice.

This point is developed explicitly in *Neutrino Oscillations as Internal Mode Interference in the Vacuum Pressure Field* (2025) and systematized within the neutrino sector of *General Cosmology of Quarkbase (Neutrino)*.

6.2 The ontological problem with neutrino masses

Assigning tiny masses to neutrinos introduces a structural anomaly. These masses are many orders of magnitude smaller than those of other fermions, lack a generative mechanism, and require additional assumptions—Dirac versus Majorana character, mixing matrices, sterile sectors, symmetry extensions—that do not connect to the rest of particle physics.

More importantly, neutrino masses contradict the **observed ontological role** of neutrinos. Neutrinos behave experimentally as **phase carriers**, not as localized inertial objects. They propagate almost unattenuated, maintain coherence over vast distances, and interact primarily through boundary conditions rather than inertia.

Treating neutrinos as miniature charged fermions with vanishingly small masses obscures rather than clarifies their physical function. The mass hypothesis explains oscillations mathematically, but at the cost of introducing a new hierarchy problem with no physical origin.

6.3 Internal mode interference in $N = 1$

In Quarkbase Cosmology, the neutrino corresponds to the elementary compactation ($N = 1$) of the Ψ-field. Although minimal, this compactation is not dynamically trivial. The continuity and elasticity of the Ψ-field allow a **finite set of internal vibrational modes** even at this level.

These modes are not particles, flavors, or eigenstates. They are **internal phase configurations** of a single physical object. During propagation, a neutrino exists as a coherent superposition of these internal modes, each accumulating phase at a slightly different rate due to coupling with the surrounding Ψ-field.

Schematically,

$$\Psi_{N=1}(x,t) = \sum_{i=1}^{3} c_i \, \psi_i \, e^{i\phi_i(x,t)}.$$

Oscillations arise inevitably as a **mode-beating phenomenon**. No additional entities are introduced. No intrinsic masses are required.

This mechanism is derived and discussed in detail in *Neutrino Oscillations as Internal Mode Interference in the Vacuum Pressure Field* (2025).

6.4 Why L/E scaling emerges naturally

The accumulated phase difference between internal modes depends on propagation distance and excitation energy through the Ψ-field. In a frictionless continuous medium, phase accumulation scales as

$$\Delta\phi_{ij} \;\propto\; \frac{L}{E}\,\Delta\omega_{ij},$$

where $\Delta\omega_{ij}$ reflects internal mode structure, not rest mass.

The familiar L/E scaling therefore emerges **without invoking relativistic mass terms**. The standard oscillation formula is recovered as an effective description of internal interference:

$$\sin^2\!\left(\frac{\Delta m^2 L}{4E}\right) \;\longleftrightarrow\; \sin^2\!\left(\frac{\Delta\omega\, L}{E}\right).$$

In this framework, the mass parameter Δm^2 is a proxy for internal phase structure, not a fundamental property.

6.5 Why there are exactly three "flavors"

The existence of three—and only three—observable leptonic channels follows from the same structural principle governing higher compactations. The internal spectrum of the ($N = 1$) compactation supports **exactly three stable vibrational modes** compatible with Ψ-field continuity and stability.

Flavor, therefore, is not an intrinsic label of the neutrino. It is a **property of the interaction channel**:

- production prepares a specific superposition of internal modes,
- detection projects onto another.

Between these boundaries, the neutrino remains a single entity.

This removes the need for family replication as a postulate and links neutrino behavior directly to the leptonic hierarchy developed later in *The Leptonic Spectrum of the Ψ-Field* (2025).

6.6 Matter effects without new physics

When neutrinos propagate through matter, the surrounding leptonic environment modifies the boundary conditions of the Ψ-field. This alters the effective phase velocities of internal modes and shifts oscillation patterns.

Standard MSW phenomenology is recovered, but its origin is reinterpreted as a **medium-dependent modification of internal mode interference**, not as a resonance between massive eigenstates.

This reinterpretation predicts:

- deviations from standard MSW behavior in non-standard Ψ-field environments,
- sensitivity to structured media beyond electron density alone.

These effects are absent in the mass-eigenstate framework and provide a clear experimental discriminator.

6.7 Structural continuity and falsifiability

Neutrino oscillations are not an isolated phenomenon. They are the **simplest observable manifestation** of internal structure within Ψ-field compactations. The same mechanism reappears, with increasing complexity, in:

- charged-lepton resonances,
- hadronic confinement,
- nuclear and condensed-matter structures.

Crucially, this interpretation is falsifiable. It predicts:

- additional weak oscillation components,
- controlled departures from exact L/E scaling,
- environment-dependent phase shifts not reducible to MSW effects.

These predictions are detailed within the Quarkbase neutrino corpus and do not exist within the mass-eigenstate paradigm.

With neutrino oscillations grounded in physical ontology rather than parameter insertion, the analysis now turns to the next structural layer: **the origin of the charged-lepton spectrum and its hierarchy**.

7 The leptonic spectrum as a resonant structure

7.1 The hierarchy problem restated

The existence of three charged leptons—electron, muon, and tau—with identical quantum numbers but vastly different masses is one of the clearest signals that the Standard Model lacks a generative mechanism. The hierarchy is not marginal; it spans more than three orders of magnitude:

$$m_e \ll m_\mu \ll m_\tau.$$

Nothing in gauge symmetry, renormalization, or spontaneous symmetry breaking explains why these values exist, why there are **exactly three**, or why no intermediate states appear. No principle constrains their ratios, their number, or their stability.

Within the Standard Model, this spectrum is not derived. It is *declared*.

Any framework that claims fundamentality must explain why the leptonic spectrum is **discrete, finite, and hierarchically ordered**, rather than continuous or arbitrarily extended.

This problem is addressed explicitly in *The Leptonic Spectrum of the* Ψ*-Field* (2025), where the hierarchy is treated as a structural consequence rather than a fitted input.

7.2 Failure of Yukawa-based explanations

Yukawa couplings merely parametrize ignorance. Assigning different coupling constants (y_f) to different fermions,

$$m_f = y_f\, v,$$

does not explain mass; it labels it. The fact that these couplings must span many orders of magnitude without pattern or constraint is not a feature—it is an admission of incompleteness.

Moreover, Yukawa terms are **structurally disconnected** from every other aspect of the theory. They do not relate to:

- neutrino behavior,
- confinement,
- irreversibility,
- or cosmology.

They are isolated knobs, adjusted independently of the rest of physics.

A physical hierarchy cannot arise from arbitrary constants. It must emerge from **structure**.

7.3 From $N = 1$ to $N = 13$: the first stable closure

In Quarkbase Cosmology, charged leptons are not elementary. They correspond to the **first nontrivial stable compactation** of the Ψ-field beyond the neutrino. This compactation occurs at

$$N = 13,$$

forming the smallest closed, self-consistent structure capable of sustaining:

- electric charge,
- spin,
- and inertial response.

The electron is therefore not a point particle but a **resonant configuration of thirteen** ($N = 1$) **units**. Its stability follows from **geometric closure**, not from imposed symmetry or conserved quantum numbers.

Charge emerges as a topological feature of rotational imbalance within this compactation, not as a primitive attribute. This mechanism is developed in detail in *The Leptonic Spectrum of the* Ψ*-Field* (2025) and grounded ontologically in *Genesis Quarkbase*.

This immediately explains why the electron is both stable and unique.

7.4 Muon and tau as higher resonant modes

The muon and tau are not new particles. They are **excited resonant modes** of the same ($N = 13$) compactation. Their higher energies correspond to higher internal vibrational states of the same geometric structure.

This explains, without additional assumptions:

- why muon and tau carry exactly the same charge and spin as the electron,
- why they are unstable,
- why they decay into the electron channel,
- why no fourth charged lepton exists.

The spectrum is discrete because the compactation supports **only a finite number of stable resonant modes**. Beyond this range, the structure destabilizes and recomposes.

No family replication principle is required.

7.5 Why the hierarchy is so steep

The mass gaps between electron, muon, and tau are not linear because the energy stored in a compactation does not scale linearly with excitation index. It scales with **internal stress and phase deformation** of the Ψ-field under geometric constraint.

Schematically,

$$E_n \sim \int_{\text{compact}} (\nabla \Psi_n)^2 \, dV,$$

so small changes in mode structure can produce large changes in effective inertial response.

The steepness of the hierarchy is therefore not a tuning problem. It is a natural outcome of resonance physics in a constrained continuous medium.

7.6 Structural continuity with neutrinos

The internal-mode structure responsible for leptonic hierarchy is already present in embryonic form at $(N = 1)$. Neutrino oscillations and charged-lepton hierarchy are not separate phenomena; they are **successive manifestations of the same underlying mechanism**.

- At $(N = 1)$: internal mode interference produces oscillations.
- At $(N = 13)$: internal modes produce stable charge and resonant mass states.

This continuity is decisive. The theory does not reset its principles when moving from neutrinos to electrons. The same ontology applies without modification, as developed consistently across the Quarkbase corpus.

7.7 Predictive closure

Because leptons are resonant structures rather than elementary particles, the framework makes non-negotiable predictions:

- no additional charged leptons exist,
- decay channels reflect internal mode transitions,
- lifetimes depend on Ψ-field coupling conditions,
- extreme environments may modulate decay rates in specific, constrained ways.

These predictions are **structural**, not adjustable. Altering them would break the internal consistency of the framework.

With the leptonic hierarchy explained as a geometric inevitability rather than a fitted spectrum, the analysis advances to a problem where the Standard Model openly acknowledges conceptual failure: **color confinement**.

8 Color confinement as a geometric necessity

8.1 The unresolved status of confinement

Color confinement is not a minor technical issue; it is a foundational gap. Quantum Chromodynamics (QCD) reproduces hadronic spectra and scattering data with remarkable precision, yet it does not derive—analytically and from first principles—why isolated quarks do not exist. Confinement is demonstrated numerically, primarily through lattice simulations, but it is not **explained physically**.

An absolute phenomenon demands an absolute reason. The statement that the strong coupling “grows with distance” is not an explanation; it is a restatement of behavior. It does not answer *why* separation is forbidden in principle.

This unresolved status is analyzed directly in *Color Confinement — The Unresolved Structural Anomaly of QCD* (2025), where confinement is shown to lack an ontological foundation within gauge dynamics alone.

8.2 Why confinement cannot be a force

Interpreting confinement as a force leads to immediate conceptual contradictions. Forces, by definition, can be overcome with sufficient energy. Confinement cannot. No experiment—at any energy scale—has ever produced a free quark.

This empirical fact alone rules out any interpretation of confinement as an interaction mediated by exchange particles. A mediator can be screened, modified, or bypassed. Confinement cannot.

Therefore, confinement cannot be dynamical in origin. It must be **structural**.

The correct explanation must prohibit quark isolation **by construction**, not by energetic penalty.

8.3 Compactation and topological continuity

In Quarkbase Cosmology, hadrons correspond to the **second stable compactation** of the Ψ-field, occurring at

$$N = 55.$$

This compactation forms a closed, mechanically stable structure composed of multiple internal domains. These domains correspond to what are conventionally labeled "quarks," but they are not independent entities.

They are **inseparable regions of a single compact structure**.

Attempting to extract one domain would require tearing the Ψ-field and breaking topological continuity. This operation is not energetically suppressed; it is **physically undefined**. The field does not admit partial closures.

Confinement follows automatically from continuity:

$$\text{compact structure} \not\to \text{isolated subdomain.}$$

This mechanism is developed in detail in *Color Confinement — The Unresolved Structural Anomaly of QCD* (2025) and grounded in the general compactation framework of *Genesis Quarkbase.*

8.4 Color as a geometric partition, not a charge

The threefold "color" structure of quarks reflects the **geometric partition** of the ($N = 55$) compactation into three mutually coupled internal domains required for mechanical and topological stability.

Color is not:

- a charge carried by particles,
- an abstract gauge label,
- a symmetry to be imposed.

It is a **geometric constraint imposed by closure**.

This immediately explains:

- why exactly three colors exist,

- why color must be neutralized in observable states,
- why gluons never appear as free asymptotic particles.

Gauge descriptions successfully parametrize interactions *within* the compactation, but geometry enforces confinement *of* the compactation.

No additional principle is required.

8.5 Why free quarks cannot exist

A free quark would correspond to an isolated fragment of a compactation. Such an object cannot exist within a continuous medium that enforces closure.

The Ψ-field permits:

- complete compactations,
- or recomposition into allowed lower-order structures.

It does not permit partial, open-ended fragments.

This is stronger than confinement by force. It is **exclusion by ontology**.

Free quarks are not merely unobserved; they are **undefined** within the physical substrate.

8.6 Continuity with leptons and neutrinos

Confinement is not a special rule introduced *ad hoc* for hadrons. It is the same structural principle already encountered at lower compactation orders:

- neutrinos cannot fragment because ($N = 1$) is minimal,
- electrons are stable because ($N = 13$) is closed,
- hadrons confine because ($N = 55$) is indivisible.

The same ontological logic applies across all scales:

$$N = 1 \ \rightarrow \ \text{minimal}, \quad N = 13 \ \rightarrow \ \text{closed}, \quad N = 55 \ \rightarrow \ \text{inseparable}.$$

This continuity is decisive. The theory does not introduce new rules when moving from leptons to hadrons.

8.7 Consequence: confinement without QCD extensions

Once confinement is understood as geometric necessity, several long-standing questions dissolve naturally:

- asymptotic freedom reflects internal mode decoupling at high energy,
- the growth of effective coupling at low energies reflects enforced continuity,
- exotic color states are forbidden *a priori*,

- color deconfinement corresponds to recomposition, not liberation.

No new dynamics, particles, or symmetry extensions are required.

With confinement reduced from a mysterious force to a structural inevitability, the framework turns to another asymmetry that has resisted explanation for decades: **the observed imbalance between matter and antimatter**.

9 Matter–antimatter asymmetry without symmetry breaking

9.1 The failure of baryogenesis scenarios

The observed dominance of matter over antimatter is one of the most decisive empirical facts about the universe. In the Standard Model and its extensions, this asymmetry is treated as a dynamical accident: a small imbalance generated in the early universe through CP violation, departure from equilibrium, and finely tuned initial conditions.

Despite decades of work, no baryogenesis scenario has produced a quantitatively compelling and experimentally confirmed explanation. CP violation is observed, but it is orders of magnitude too weak. Additional CP-violating sectors are postulated, but they remain speculative and unconstrained. The asymmetry is explained *in principle*, not in fact.

This persistent failure is not accidental. It indicates that the problem has been posed incorrectly from the outset.

A detailed critique of baryogenesis assumptions and their incompatibility with a unified physical ontology is developed in *Law of Antimatter Emergence in Quarkbase Cosmology* (2025).

9.2 The ontological error: treating antimatter as symmetric matter

Standard approaches assume that matter and antimatter are fundamentally symmetric entities, distinguished only by quantum numbers. Under this assumption, asymmetry must be *produced* dynamically by breaking an initial symmetry.

Quarkbase Cosmology rejects this premise.

Matter and antimatter are not symmetric initial states. They correspond to **opposite phase orientations of compactations within the Ψ-field**. This distinction is not dynamical and local; it is **geometric and global**.

Once compactations form within a continuous medium with global structure, there is no reason—empirical or physical—to expect equal populations of both orientations.

Symmetry is not broken. It is never present.

9.3 Antimatter as geometric inversion

In this framework, antimatter corresponds to a compactation whose internal phase orientation is inverted relative to the surrounding Ψ-field. This inversion is perfectly consistent locally and respects all known CPT constraints at the level of local dynamics.

However, it couples differently to the **global Ψ-field gradients** generated during cosmic evolution.

As the universe evolves away from its primordial homogeneous state, large-scale Ψ-field gradients develop. These gradients act as a selection mechanism:

$$\text{phase orientation} \xrightarrow{\nabla\Psi} \text{global stability bias.}$$

One orientation is dynamically favored; the other is progressively suppressed. The result is a **structural bias**, not a stochastic imbalance.

Matter dominance is therefore not produced by rare events or fine tuning. It is **selected by geometry**.

This mechanism is developed quantitatively in *Law of Antimatter Emergence in Quarkbase Cosmology* (2025) and integrated into the general framework of *Genesis Quarkbase*.

9.4 Why large-scale annihilation never occurred

If matter and antimatter compactations were produced in equal amounts and uniformly mixed, large-scale annihilation would be unavoidable. The absence of such annihilation is often treated as an additional mystery.

In Quarkbase Cosmology, no such mystery exists.

Matter and antimatter compactations do not form interpenetrating homogeneous mixtures. Due to their opposite phase coupling to the evolving Ψ-field, they **segregate dynamically** from the outset. Their interaction is suppressed not by distance alone, but by incompatible global coupling.

Annihilation is therefore localized and self-limiting, not cosmologically dominant.

The observed universe does not require hidden antimatter domains, distant antimatter galaxies, or finely tuned separation mechanisms. It requires no domains at all.

9.5 No need for CP violation beyond observation

CP violation exists as a local interaction effect, and Quarkbase Cosmology does not deny it. However, it is **not responsible for the cosmic matter–antimatter asymmetry**.

The asymmetry is already encoded in the global evolution of the Ψ-field once compactations form. CP violation affects decay rates and local processes; it does not set the global inventory of matter versus antimatter.

This removes the need for:

- speculative high-energy CP-violating sectors,
- finely tuned out-of-equilibrium conditions,
- anthropic explanations.

The asymmetry is a consequence of *how* structure forms in a continuous medium, not of *what* interaction terms appear in a Lagrangian.

9.6 Structural continuity

The same principle encountered repeatedly throughout the framework reappears here. Once a compactation crosses a structural threshold, **global recomposition of the Ψ-field enforces a preferred outcome**.

Matter–antimatter asymmetry is another manifestation of **conditional irreversibility**, now applied to phase orientation rather than temporal direction.

- Time irreversibility selects temporal direction.
- Compactation geometry selects phase orientation.

Both arise from the same ontological mechanism.

With antimatter reinterpreted geometrically rather than symmetrically, the framework advances to the largest scale at which the same ontology must hold: **the organization of the universe itself**.

10 Large-scale structure without dark matter

10.1 The observational fact, not the hypothesis

The large-scale universe is not randomly distributed. Galaxies trace filaments, sheets, and voids forming a coherent cosmic web. These structures appear early, persist over cosmological times, and exhibit correlations across vast distances.

These are observations. **Dark matter is not.**

The standard cosmological model explains this organization by postulating a dominant, collisionless, non-baryonic component that seeds gravitational collapse. Despite its central role, this component has never been directly detected. Its properties are inferred *a posteriori* to reproduce structure formation, not derived from first principles.

In contrast, the filamentary morphology itself—its geometry, coherence, and scaling—is an empirical constraint that any fundamental theory must satisfy.

This constraint is addressed directly in *Filamentation and Supercluster Formation in a Three-Phase Etheric Plasma* (2025) and integrated within *Genesis Quarkbase*.

10.2 Why collisionless particles are an unnatural solution

Invoking invisible matter to explain visible structure introduces a conceptual asymmetry: the dominant component of the universe does not participate in the interactions that define observed physics. This does not resolve the problem; it displaces it.

More critically, **collisionless particles are structurally ill-suited** to produce the observed morphology. Filaments resemble self-organized structures typical of continuous media—plasmas, elastic fields, and pressure-supported systems—rather than aggregates of non-interacting point masses.

Their:

- elongated geometry,
- long-range coherence,

- hierarchical branching,
- and persistence under perturbation

are characteristic of **instability and relaxation in a medium**, not of collisionless clustering.

This resemblance is not accidental; it is diagnostic.

10.3 Structure formation as a Ψ-field instability

In Quarkbase Cosmology, the universe is permeated by the Ψ-field. As compactations form and proliferate, they displace Ψ-field volume and generate global pressure gradients. These gradients do not relax isotropically.

In a frictionless elastic medium, relaxation proceeds through **anisotropic instabilities**, producing preferred directions of stress release. The natural outcome is a network of filaments, nodes, and voids.

Schematically,

$$\nabla \cdot \sigma_\Psi \neq 0 \quad \Rightarrow \quad \text{anisotropic relaxation} \;\rightarrow\; \text{filamentation.}$$

Large-scale structure therefore emerges as a **collective response of a continuous medium** to distributed compactations, not as hierarchical clustering of point masses.

No additional matter component is required.

This mechanism is developed quantitatively in *Filamentation and Supercluster Formation in a Three-Phase Etheric Plasma* (2025).

10.4 Why filaments form first

In a frictionless elastic medium, the fastest-growing instabilities are not spherical. They are elongated. This is a general result of continuum dynamics and does not depend on fine-tuned initial conditions.

Filaments therefore form **before** halos, not after.

This reverses the logic of standard structure formation. Galaxies do not fall into pre-existing dark-matter potential wells. They condense preferentially at the **intersections of Ψ-field filaments**, where pressure gradients and field curvature concentrate.

This explains, without auxiliary assumptions:

- the early appearance of large-scale structure,
- the ubiquity of filamentary geometry,
- the tight correlation between baryonic matter and inferred gravitational potential.

10.5 Apparent "dark matter" effects as field response

Rotation curves, gravitational lensing, and cluster dynamics are usually interpreted as evidence for unseen mass. In Quarkbase Cosmology, these phenomena reflect the **elastic response of the Ψ-field** to displaced volume.

Gravity is not sourced by mass density alone, but by **Ψ-field gradients induced by compactations**:

$$\mathbf{g} \propto -\nabla\Psi.$$

The excess gravitational effects attributed to dark matter arise naturally from field deformation extending beyond the visible matter distribution.

This preserves all successful phenomenology—rotation curves, lensing maps, cluster dynamics—while eliminating an undetected ontological category.

The reinterpretation of gravity in this context is consistent with *Plancks Constant as the Mechanical Coupling of the Etheric Plasma* (2025) and the cosmological synthesis in *General Cosmology of Quarkbase (Neutrino).*

10.6 Predictive distinction

If large-scale structure arises from Ψ-field dynamics rather than collisionless matter, then clear observational distinctions follow:

- filament properties should correlate with plasma-like behavior and field continuity,
- structure formation should be sensitive to early Ψ-field conditions rather than particle properties,
- deviations from ΛCDM predictions should appear at scales where continuum effects dominate over point-mass approximations.

These distinctions are testable and do not depend on discovering new particles.

10.7 Structural closure

Cosmic structure formation is not an exception to the framework; it is its **largest-scale expression**. The same ontological principles governing:

- neutrino oscillations,
- leptonic hierarchy,
- confinement,
- matter–antimatter asymmetry,

operate without modification at cosmological scales.

With this, Quarkbase Cosmology addresses phenomena spanning more than thirty orders of magnitude using a **single physical ontology**.

The remaining task is not to add further explanations, but to state clearly the implications of accepting this unification.

11 What must be false if Quarkbase Cosmology is correct

If Quarkbase Cosmology is correct, then its implications are not optional. A framework that explains irreversibility, hierarchy, confinement, antimatter asymmetry, and cosmic structure from a single physical ontology necessarily **excludes** a number of assumptions that are currently treated as foundational. This section states those exclusions explicitly.

The purpose is not rhetorical. It is methodological. A theory that claims explanatory unification must be clear about what it renders unnecessary, inconsistent, or false.

11.1 Dark matter as a fundamental component of the universe must not exist

If large-scale structure arises from anisotropic instabilities and elastic response of a continuous Ψ-field, then a dominant, collisionless, non-baryonic matter component is not only unnecessary—it is incompatible with the ontology.

In particular, it must be false that:

- the cosmic web is seeded by gravitational collapse of invisible particles,
- galaxy rotation curves require unseen mass halos,
- gravitational lensing maps trace a hidden matter distribution distinct from baryonic structure.

What is currently interpreted as "dark matter" must instead be the **field response of the Ψ-medium** to displaced volume. Any future direct detection of collisionless dark matter particles with the required cosmological abundance would therefore falsify the framework.

11.2 Neutrino oscillations must not originate from intrinsic neutrino masses

If neutrino oscillations are caused by internal mode interference within the elementary compactation ($N = 1$), then neutrinos must not possess intrinsic rest masses in the conventional sense.

Consequently:

- mass eigenstates cannot be physically fundamental,
- neutrino flavor change must not correspond to propagation of massive states,
- oscillation phenomenology must admit deviations from the mass-based paradigm under controlled conditions.

A definitive, unambiguous measurement of nonzero neutrino rest mass as a fundamental inertial property—independent of phase interference interpretation—would contradict Quarkbase Cosmology at its most elementary level.

11.3 Fermion mass hierarchy must not be arbitrary or continuous

If charged leptons are resonant structures of a single compactation at ($N = 13$), then the observed spectrum must be:

- discrete,
- finite,
- structurally constrained.

It must therefore be false that:

- fermion masses are free parameters set by unrelated Yukawa couplings,
- additional charged leptons can exist at higher energies,
- mass ratios are accidental or environmentally selected.

The discovery of a fourth charged lepton, or evidence that lepton masses vary continuously with energy scale or environment in a way incompatible with resonance structure, would invalidate this explanation.

11.4 Color confinement must not be a force-mediated phenomenon

If confinement is a consequence of topological continuity of compactations at ($N = 55$), then it must be false that:

- confinement is caused by an exchange force that grows with distance,
- quarks could, even in principle, exist as isolated asymptotic states,
- deconfinement corresponds to liberation of quarks rather than structural recomposition.

Any experimental demonstration of a free quark—regardless of energy scale—would immediately falsify the geometric confinement mechanism.

11.5 Matter–antimatter asymmetry must not be generated dynamically by CP violation

If matter dominance results from geometric phase orientation selection during Ψ-field evolution, then it must be false that:

- the universe began in a matter–antimatter symmetric state,
- cosmic asymmetry was generated by rare CP-violating processes,
- additional CP-violating sectors are required to explain cosmology.

While CP violation exists locally, it must not control the global matter inventory of the universe. A confirmed baryogenesis mechanism producing the observed asymmetry quantitatively, without invoking geometric selection, would directly contradict this framework.

11.6 The arrow of time must not be purely statistical

If irreversibility arises from vacuum recomposition across structural thresholds, then it must be false that:

- times arrow is only an emergent statistical tendency,
- macroscopic irreversibility is reducible to coarse-graining,
- all physical processes are fundamentally reversible in practice.

Observable phenomena must exist—and do exist—where reversal is not merely improbable but physically undefined. Any complete statistical explanation of irreversibility that does not invoke structural non-invertibility would undermine the core mechanism proposed here.

11.7 Fundamental physics must not be ontologically plural

Finally, if Quarkbase Cosmology is correct, it must be false that nature requires:

- separate ontological entities for forces, particles, fields, and spacetime,
- independent mechanisms for time, mass, confinement, and cosmology,
- layered explanations patched together across scales.

Physics must admit a **single physical substrate** from which all observed structure emerges as different regimes of the same dynamics.

If future theory or experiment demonstrates that irreversibility, hierarchy, confinement, and cosmic structure arise from genuinely unrelated physical causes, then the unification proposed here is wrong.

11.8 The risk is real—and necessary

These exclusions are not hedged. They are not adjustable. They represent genuine points of failure.

That is intentional.

A framework that explains everything but forbids nothing explains nothing. Quarkbase Cosmology makes itself vulnerable precisely because it replaces parameter management with physical necessity.

If it is correct, much of modern theoretical scaffolding is not merely incomplete—it is conceptually misplaced. If it is wrong, it will fail decisively.

Either outcome advances physics.

Bibliography

References

[1] C. Omeñaca Prado, *Genesis Quarkbase*, Independent Research Preprint, 2025. Available at: https://quarkbase-cosmology.com

[2] C. Omeñaca Prado, *General Cosmology of Quarkbase (Neutrino)*, Independent Research Preprint, 2025.

[3] C. Omeñaca Prado, *Conditional Irreversibility and the Emergence of the Time Arrow from Vacuum Recomposition*, Independent Research Preprint, 2025.

[4] C. Omeñaca Prado, *Neutrino Oscillations as Internal Mode Interference in the Vacuum Pressure Field*, Independent Research Preprint, 2025.

[5] C. Omeñaca Prado, *The Leptonic Spectrum of the* Ψ*-Field*, Independent Research Preprint, 2025.

[6] C. Omeñaca Prado, *Color Confinement — The Unresolved Structural Anomaly of QCD*, Independent Research Preprint, 2025.

[7] C. Omeñaca Prado, *Law of Antimatter Emergence in Quarkbase Cosmology*, Independent Research Preprint, 2025.

[8] C. Omeñaca Prado, *Filamentation and Supercluster Formation in a Three-Phase Etheric Plasma*, Independent Research Preprint, 2025.

[9] C. Omeñaca Prado, *Plancks Constant as the Mechanical Coupling of the Etheric Plasma*, Independent Research Preprint, 2025.