Law of Antimatter Emergence in Quarkbase Cosmology

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Abstract

We derive a structural, medium-based criterion for the existence of antimatter within the framework of Quarkbase Cosmology. Antimatter is not postulated as a parallel sector nor as a remnant of a primordial symmetry, but emerges conditionally from the dynamics of the Ψ-field. A single operational principle—the conjugation of phase and orientation combined with mechanical admissibility—determines whether a given excitation admits a distinct antiparticle, is self-conjugate, or is structurally forbidden from having an antimatter counterpart. The criterion is applied systematically to leptons, neutrinos, electromagnetic modes, baryons, mesons, and composite nuclear states, yielding a unified classification that accounts for the observed pattern of antimatter and leads to explicit, falsifiable predictions beyond the Standard Model.

Contents

1 Framework and Motivation

In Quarkbase Cosmology, all physical entities arise as **stable excitations or compactations of a continuous physical medium**, the Ψ-field. This medium is not a mathematical abstraction but a real dynamical substrate capable of sustaining longitudinal modes, transverse modes, geometric closures, and hierarchical aggregates thereof. Within this framework, there is no ontological separation between "particles" and "fields": both are manifestations of organized Ψ-field dynamics at different structural levels.

Crucially, Quarkbase Cosmology does **not** postulate a Big Bang, an initial singularity, or an *a priori* symmetric creation of matter and antimatter. There is no primordial event in which equal quantities of matter and antimatter must be assumed and subsequently "explained away." Instead, the universe is described as an evolving medium whose allowed structures are determined by **mechanical admissibility, stability, and coherence**.

As a consequence, the conventional framing of the matter–antimatter problem is fundamentally altered. The relevant question is no longer why an initially symmetric universe evolved into an asymmetric one, but rather:

Under what structural conditions does an excitation of the Ψ-field admit a distinct conjugate excitation identifiable as antimatter?

Within this perspective, antimatter is neither a universal companion to matter nor an arbitrary duplication of states enforced by algebraic symmetry. Its existence is **conditional**, emerging only when the underlying Ψ-field configuration supports a stable conjugate realization.

This work demonstrates that the existence or non-existence of antimatter counterparts is governed by three intertwined properties of the Ψ-field excitation:

- **orientation** (or handedness) of its dynamical pattern,
- **topological structure** of the associated compactation,
- and **mechanical stability** of the conjugated configuration.

Antimatter, in Quarkbase Cosmology, is therefore an **emergent structural phenomenon**, not a fundamental postulate.

2 Minimal Operational Definitions

To formalize the emergence of antimatter within this framework, only two minimal and operational concepts are required: a conjugation operator and a criterion of admissibility.

2.1 Conjugation Operator (C)

We define the **conjugation operator** (C) as the inversion of the **orientation**—that is, the phase or topological handedness—of the Ψ-field pattern associated with a given excitation, while preserving its geometric compactation.

Formally, an excitation is represented as a pair

$$X \equiv (G, P),$$

where:

- G denotes the compactation geometry (closures, aggregates, spatial organization),
- P denotes the dynamical pattern of the Ψ-field (phase structure, flows, internal modes).

The action of conjugation is defined as

$$C : (G, P) \longrightarrow (G, P^*),$$

where P^* represents the orientation-inverted (conjugated) Ψ-field pattern.

Importantly, the operator C **does not** alter the geometry G. It acts solely on the orientational and dynamical degrees of freedom of the Ψ-field. This reflects the physical idea that antimatter, when it exists, corresponds to the same structural organization realized with opposite orientation in the medium.

However, the existence of a conjugated pattern (G, P^*) is **not guaranteed**. The conjugate excitation is said to be **physically admissible** only if it constitutes a **stable solution** of the Ψ-field dynamics—i.e., if it possesses a well-defined minimum of the relevant energy functional and does not collapse, delocalize, or decay immediately.

This admissibility condition is essential. It is precisely what allows Quarkbase Cosmology to predict:

- which excitations possess distinct antiparticles,
- which are self-conjugate,
- and which admit no antimatter counterpart at all.

2.2 Orientational Signature (Q)

To decide whether the conjugation operator (C) generates a **distinct physical excitation** or merely reproduces the same state, we introduce a single invariant quantity: the **orientational signature** (Q).

2.2.1 Definition

The orientational signature (Q) is a **pseudo-scalar** that measures the net handedness (chirality/helicity) of the Ψ-field pattern associated with an excitation (X). Operationally, it is defined as

$$Q(X) = \int_{\Omega_X} \mathbf{v}_\Psi \cdot (\nabla \times \mathbf{v}_\Psi)\; d^3x,$$

where:

- $\mathbf{v}_\Psi$ denotes the effective flow or phase-gradient field of the Ψ-medium associated with the excitation,
- Ω_X is the spatial domain over which the excitation is localized.

This definition is deliberately minimal. Only the **sign** and **nullity** of Q matter; its absolute magnitude is secondary for classification purposes.

2.2.2 Transformation under conjugation

By construction, the orientational signature transforms as

$$Q(CX) = -Q(X).$$

This immediately yields two mutually exclusive cases:

- $Q(X) \neq 0$: the excitation carries a definite orientation. Conjugation produces a pattern with opposite orientation.
- $Q(X) = 0$: the excitation has no net orientation. Conjugation leaves it invariant.

Thus, Q provides a sharp and physically meaningful criterion for distinguishing between states that can support a distinct antimatter counterpart and those that cannot.

2.2.3 Physical meaning

The quantity Q does **not** represent electric charge, baryon number, or any abstract internal quantum number. It encodes a **geometric–dynamical property of the medium itself**: whether the excitation organizes the Ψ-field with a preferred handedness.

This distinction is crucial:

- An excitation may be electrically neutral and still have $Q \neq 0$ (e.g., the neutron).
- Conversely, an excitation may involve oscillatory or propagating modes and still have $Q = 0$ (e.g., electromagnetic modes).

In Quarkbase Cosmology, orientation is more fundamental than charge. Charges emerge as secondary bookkeeping labels for how oriented Ψ-field patterns interact.

2.2.4 Why Q is sufficient

No additional invariants are required to decide the existence of antimatter counterparts. Once:

1. the orientational signature Q is known, and
2. the mechanical admissibility of the conjugated pattern is checked,

the classification is complete.

This economy is not an assumption but a consequence of the medium-based ontology:

- If the Ψ-field does not carry a signed orientation, there is nothing to invert.
- If inversion destroys stability, the medium itself forbids the conjugate state.

2.2.5 Immediate consequences

From the properties of Q, three classes of excitations emerge naturally:

1. **Oriented states ($Q \neq 0$)**
   These states *may* admit antimatter counterparts, subject to stability under C.

2. **Non-oriented states ($Q = 0$)**
   These states are **self-conjugate**. They do not require, nor admit, a distinct antimatter partner.

3. **Frustrated states ($Q \neq 0$, but C inadmissible)**
   These states possess orientation but cannot be realized in the conjugated form. They have **no antimatter analogue in principle**.

This trichotomy replaces the traditional binary matter/antimatter division with a **structural classification** grounded in the physics of the Ψ-field.

2.3 Mechanical Admissibility and Stability Criterion

The orientational signature (Q) determines whether a conjugated excitation is *distinct* from the original. Mechanical admissibility determines whether that conjugated excitation can **exist at all**.

This section formalizes the second condition of the Quarkbase criterion: **stability of the conjugated state**.

2.3.1 Stability as a property of the medium

In Quarkbase Cosmology, stability is not imposed by symmetry arguments or conserved quantum numbers. It is a **mechanical property of the Ψ-field**.

An excitation $X = (G, P)$ is physically admissible if and only if the Ψ-field admits a **localized, bounded, and energetically stationary solution** corresponding to that configuration. Concretely, this requires:

- localization of the pattern within a finite region,
- bounded energy with respect to small perturbations,
- absence of runaway modes or delocalization,
- coherence between internal modes and the surrounding Ψ-field.

These conditions apply equally to X and to its conjugate $C(X)$.

2.3.2 Definition of admissibility under conjugation

Let $X = (G, P)$ be a stable excitation. The conjugated configuration is

$$C(X) = (G, P^*),$$

where P^* denotes inversion of orientation/phase.

We say that $C(X)$ **is mechanically admissible** if (G, P^*) also satisfies the stability conditions of the Ψ-field.

This requirement is **non-trivial**. Although the geometry G is preserved, the inverted pattern P^* may:

- violate boundary conditions imposed by the surrounding medium,
- couple destructively to background Ψ-field modes,
- eliminate the energy minimum that stabilized the original excitation,
- induce internal mode frustration or phase incompatibility.

When any of these occurs, the conjugated configuration cannot exist as a physical excitation.

2.3.3 Why admissibility is not guaranteed by symmetry

In conventional field theories, conjugate states are often guaranteed by algebraic symmetry (e.g. CPT). In Quarkbase Cosmology, **the medium breaks that guarantee**.

The Ψ-field is:

- continuous but structured,
- coherent but not abstractly symmetric,
- capable of supporting some orientations better than others.

As a result, the following situations naturally arise:

- two orientations are mathematically definable, but only one is mechanically stable,
- the energy functional is not invariant under orientation inversion,
- dissipation or mode coupling differs between P and P^*.

This means that antimatter is **not forbidden by hand**, nor universally required. It is **filtered by the medium**.

2.3.4 Relation to asymmetry without initial conditions

This admissibility criterion replaces all "initial asymmetry" arguments.

There is no need to assume:

- an initially symmetric universe,
- a special CP-violating epoch,
- fine-tuned decay chains.

Instead:

- both X and $C(X)$ may be *allowed in principle*,
- but the Ψ-field may dynamically admit only one as stable.

Asymmetry emerges as a **selection rule**, not as a historical accident.

2.3.5 Summary of the operational test

For any excitation X:

1. compute or characterize its orientational signature $Q(X)$,
2. construct the conjugated pattern P^*,
3. test mechanical admissibility of (G, P^*).

The outcome is unambiguous:

- $Q = 0 \Rightarrow$ self-conjugate,
- $Q \neq 0$ and admissible $\Rightarrow$ antimatter exists,
- $Q \neq 0$ and inadmissible $\Rightarrow$ antimatter forbidden.

This completes the **minimal operational core** of the Quarkbase antimatter framework.

3 Law of Antimatter Emergence

We now formalize the results of Sections 1 and 2 into a single operational statement. This law is not an additional postulate; it is a **direct consequence** of the medium-based ontology of Quarkbase Cosmology.

3.1 Statement of the Law

Law (Quarkbase Criterion of Antimatter).
Let X be a stable excitation of the Ψ-field, characterized by a compactation geometry G and a dynamical pattern P. A distinct antiparticle $\bar{X} \neq X$ exists **if and only if** the following two conditions are simultaneously satisfied:

1. **Non-zero orientational signature**
   The excitation carries a signed orientational invariant:
   $$Q(X) \neq 0.$$
2. **Mechanical admissibility of the conjugate**
   The conjugated excitation
   $$C(X) = (G, P^*)$$
   constitutes a mechanically stable solution of the Ψ-field dynamics.

If either condition fails, **no distinct antiparticle exists**.

3.2 Logical completeness of the criterion

This law is logically closed. There are no hidden assumptions.

- If $Q(X) = 0$, there is no orientation to invert. Conjugation produces no new physical state.
- If $Q(X) \neq 0$ but $C(X)$ is unstable, the medium itself forbids the conjugate realization.
- Only when **both** orientation and stability are present does antimatter emerge.

No additional symmetry principles (C, CP, CPT) are required. The law is **structural**, not algebraic.

3.3 Trichotomy of physical states

The law naturally partitions all Ψ-field excitations into three mutually exclusive classes:

1. **Self-conjugate states**
$$Q(X) = 0.$$
These states are invariant under C. They do not possess, and do not require, a distinct antimatter counterpart.

2. **Conjugate-admissible states**
$$Q(X) \neq 0, \quad C(X) \text{ stable.}$$
These states admit a distinct antiparticle, realized as the orientation-inverted branch of the same structure.

3. **Conjugate-forbidden states**
$$Q(X) \neq 0, \quad C(X) \text{ unstable.}$$
These states possess orientation but cannot exist in conjugated form. Antimatter is **structurally forbidden**, not dynamically suppressed.

This trichotomy replaces the traditional binary matter/antimatter classification with a **medium-filtered ontology**.

3.4 Absence of cosmological assumptions

The law does **not** depend on:

- initial conditions,
- a primordial symmetry,
- a creation event,
- or a time-asymmetric process.

It is valid in a static, cyclic, or eternally evolving Ψ-field. Matter–antimatter asymmetry is therefore **not a historical problem**, but a **structural selection rule**.

3.5 Relation to observed antimatter

The law explains, without adjustment:

- why positrons and antiprotóns exist,
- why they appear only locally and transiently,
- why no macroscopic antimatter structures are observed,
- and why some excitations have no antimatter counterpart at all.

Importantly, it also explains **why the existence of some antiparticles does not imply universality of antimatter**.

3.6 Status of the law

The Quarkbase Criterion of Antimatter is:

- **minimal** (one invariant, one operator),
- **predictive** (decides existence/non-existence),
- **falsifiable** (see Section 8),
- **independent** of the Standard Model.

It is not a reinterpretation of baryogenesis; it is a replacement of the underlying question.

4 Application to Elementary Excitations

We now apply the Quarkbase criterion of antimatter emergence to the simplest and best-characterized excitations of the Ψ-field. These cases serve two purposes:

(i) they anchor the framework to empirically known particles, and

(ii) they demonstrate that the criterion is not tailored *ad hoc*, but applies uniformly across qualitatively different excitations.

4.1 Electron

4.1.1 Structure

In Quarkbase Cosmology, the electron is not a point particle but a **resonant excitation** of a neutral Qb–antiQb core coupled to a surrounding Ψ-shell. The physically relevant feature is that the electronic state corresponds to an **antisymmetric internal mode** of this resonator.

This antisymmetry implies a well-defined **orientation of the internal Ψ-field pattern**, rather than a purely longitudinal or purely transverse excitation.

4.1.2 Orientational signature

The electronic mode carries a **non-zero orientational signature**:

$$Q(e^-) \neq 0.$$

The Ψ-field pattern associated with the electron possesses a definite handedness that cannot be continuously deformed into its opposite without inversion of phase/orientation.

4.1.3 Admissibility under conjugation

Applying the conjugation operator (C) inverts the orientation of the internal mode while preserving the resonator geometry. Due to the symmetry of the Qb–antiQb structure, the conjugated pattern remains mechanically stable.

Thus,

$$C(e^-) \text{ is admissible.}$$

4.1.4 Result

A distinct antiparticle exists:

$$e^- \longleftrightarrow e^+.$$

The positron is not an independent ontological entity but the **conjugate branch of the same resonant structure**, realized with opposite orientation of the Ψ-field pattern.

4.1.5 Critical closure

This interpretation explains:

- why the positron has the same mass as the electron,
- why it annihilates with the electron,
- and why it appears only under energetic excitation of the medium.

No additional symmetry postulates are required.

4.2 Neutrino ($N = 1$)

4.2.1 Structure

The neutrino corresponds to the **minimal compactation** of the Ψ-field. It is a **purely longitudinal excitation**, lacking internal resonant closure or transverse circulation.

Unlike the electron, the neutrino does not involve a Qb–antiQb resonator. Its defining feature is propagation along the medium without internal orientational structure.

4.2.2 Orientational signature

Because the excitation is longitudinal and non-circulatory, the associated Ψ-field pattern carries **no net orientation**:

$$Q(\nu) = 0.$$

There is no pseudo-scalar invariant that can change sign under conjugation.

4.2.3 Admissibility under conjugation

Applying C to a longitudinal excitation produces no new physical configuration. Phase inversion does not generate a distinct stable pattern.

Thus,

$$C(\nu) = \nu.$$

4.2.4 Result

The neutrino is **self-conjugate**. There is no structurally distinct antineutrino.

The object conventionally labeled $\bar{\nu}$ corresponds to **the same physical excitation**, interpreted through opposite interaction conventions in weak processes, not to a separate Ψ-field structure.

4.2.5 Critical closure

This result:

- removes the need for a separate antineutrino ontology,
- explains why neutrino/antineutrino distinctions are interaction-based,
- and is consistent with neutrino oscillation phenomena already derived within Quarkbase.

4.3 Electromagnetic Mode ("Photon")

4.3.1 Structure

Electromagnetic radiation corresponds, in Quarkbase Cosmology, to a **transverse oscillatory mode of the Ψ-field**. It involves no compactation, no localization, and no internal closure.

The excitation is delocalized and propagating by nature.

4.3.2 Orientational signature

Although electromagnetic modes admit two helicities (±), these helicities are **internal degrees of freedom of the same excitation**, not globally oriented structures.

When evaluated over the excitation domain, the orientational invariant vanishes:

$$Q(\mathrm{EM}) = 0.$$

4.3.3 Admissibility under conjugation

Conjugation simply exchanges internal phase conventions or helicities. It does not generate a new physical object.

Thus,

$$C(\mathrm{EM}) = \mathrm{EM}.$$

4.3.4 Result

The electromagnetic mode is **self-conjugate**. There is no antifotón.
Helicity inversion corresponds to **polarization**, not to antimatter.

4.3.5 Critical closure

This explains:

- why no antifotón has ever been observed,
- why electromagnetic interactions are symmetric under charge conjugation,
- and why invoking an antifotón is unnecessary and unphysical.

4.4 Summary of elementary excitations

At the most fundamental level, the Quarkbase criterion already separates physical reality into:

- excitations with antimatter counterparts (electron),
- excitations that are intrinsically self-conjugate (neutrino, EM).

This separation emerges **before** introducing baryons, nuclei, or cosmology.

5 Application to Baryons

Baryons represent the first level of **non-leptonic compactation** in Quarkbase Cosmology. Unlike leptons, baryons involve **extended internal structure**, multiple internal modes, and a nontrivial coupling between compactation geometry and Ψ-field circulation. This makes them a decisive test for the antimatter criterion.

5.1 Proton ($N \approx 55$)

5.1.1 Structure

In Quarkbase Cosmology, the proton is a **stable barionic compactation** characterized by a closed geometric structure with multiple internal Ψ-field currents. The compactation is not reducible to a simple longitudinal or transverse mode; it necessarily involves **circulatory patterns** of the Ψ-field locked to the geometry.

This internal circulation is essential for the proton's stability and identity.

5.1.2 Orientational signature

Because the internal Ψ-field currents do not cancel globally, the proton carries a **non-zero orientational signature**:

$$Q(p) \neq 0.$$

This remains true regardless of electric charge considerations; the orientational signature is a geometric–dynamical property of the medium.

5.1.3 Admissibility under conjugation

Applying the conjugation operator (C) reverses the orientation of the internal Ψ-field circulation while leaving the compactation geometry unchanged.

Crucially, the barionic compactation admits **both orientations** as mechanically stable solutions. The inverted pattern does not violate boundary conditions, nor does it destabilize the closure.

Thus,

$$C(p) \text{ is admissible.}$$

5.1.4 Result

A distinct antiparticle exists:

$$p \longleftrightarrow \bar{p}.$$

The antiprotón corresponds to the **orientation-inverted realization of the same barionic compactation**.

5.1.5 Critical closure

This explains, without invoking quark–antiquark bookkeeping:

- why the antiprotón has the same mass as the protón,
- why annihilation occurs efficiently,
- and why antiprotóns are observed only under high-energy excitation of the Ψ-field.

Their cosmological scarcity is a **dynamical consequence**, not a structural prohibition.

5.2 Neutron ($N \approx 55$, electrically neutral)

5.2.1 Structure

The neutron belongs to the same barionic compactation class as the proton. Its electrical neutrality arises from the internal arrangement of Ψ-field modes, not from the absence of structure.

The neutron still possesses **internal Ψ-field circulation**, necessary for stability of the compactation.

5.2.2 Orientational signature

Despite having zero electric charge, the neutron carries a **non-zero orientational signature**:

$$Q(n) \neq 0.$$

Neutrality does not imply cancellation of orientational invariants. The Ψ-field pattern retains a definite handedness.

5.2.3 Admissibility under conjugation

As with the proton, inversion of orientation preserves the mechanical integrity of the compactation. The conjugated neutron pattern remains stable.

Thus,

$$C(n) \text{ is admissible.}$$

5.2.4 Result

A distinct antiparticle exists:

$$n \longleftrightarrow \bar{n}.$$

5.2.5 Critical closure

This result:

- demonstrates that **electric charge is not the criterion** for antimatter,
- explains the existence of antineutróns despite neutrality,
- and reinforces that antimatter emergence is governed by **orientation and stability**, not by charge labels.

5.3 Structural implication for baryons

The baryonic sector confirms the Quarkbase criterion in its strongest form:

- all stable barionic compactations carry $Q \neq 0$,
- all admit mechanically stable conjugates,
- therefore, **all stable baryons possess antiparticles**.

This conclusion is structural and independent of interaction details.

6 Composite and Nuclear States

Composite states probe the antimatter criterion beyond elementary compactations. They test whether antimatter emergence is merely inherited from constituents or whether **new structural constraints** appear at higher levels of organization. In Quarkbase Cosmology, composite states are not algebraic sums of particles but **collective Ψ-field configurations** whose global properties may differ qualitatively from those of their components.

6.1 Mesons (Qb–antiQb)

6.1.1 Structure

Mesons correspond to **bound configurations of a Qb–antiQb pair**. Although globally neutral in the sense of compactation balance, they are not dynamically trivial. The binding requires **circulatory Ψ-field patterns** that lock the pair into a coherent structure.

These circulatory patterns generically possess a preferred orientation.

6.1.2 Orientational signature

Because the internal Ψ-field circulation does not cancel identically, mesons carry a **non-zero orientational signature**:

$$Q(\text{meson}) \neq 0.$$

The neutrality of the Qb–antiQb pair does not imply orientational neutrality of the pattern.

6.1.3 Admissibility under conjugation

Applying C reverses the orientation of the circulation while preserving the pair geometry. The conjugated configuration remains mechanically stable.

Thus,

$$C(\text{meson}) \text{ is admissible.}$$

6.1.4 Result

Distinct antimatter counterparts exist:

$$\text{meson} \longleftrightarrow \text{anti-meson}.$$

6.1.5 Critical closure

This explains:

- why mesons and anti-mesons appear symmetrically in high-energy processes,
- why they annihilate efficiently,
- and why their existence follows directly from Ψ-field dynamics, without invoking flavor bookkeeping.

6.2 Light Nuclei (Deuteron, He-3, Tritium)

6.2.1 Structure

Light nuclei are **weakly bound aggregates of baryonic compactations**. Their stability arises from a collective Ψ-field envelope that couples the constituent baryons into a single coherent structure.

Crucially, this collective envelope introduces a **global orientational pattern** that is not simply the sum of individual baryonic orientations.

6.2.2 Orientational signature

For light nuclei such as the deuteron, helium-3, and tritium, the internal orientations do **not cancel exactly**. The aggregate therefore carries:

$$Q(\text{light nucleus}) \neq 0.$$

6.2.3 Admissibility under conjugation

Applying C inverts the global orientation of the nuclear Ψ-field envelope while preserving the aggregate geometry. For light nuclei, this inversion does not destabilize the structure.

Thus,

$$C(\text{light nucleus}) \text{ is admissible.}$$

6.2.4 Result

Distinct antimatter counterparts exist:

$$\text{nucleus} \longleftrightarrow \text{anti-nucleus.}$$

These anti-nuclei are **structurally allowed** but **dynamically rare**, consistent with observational data.

6.2.5 Critical closure

The framework explains why:

- anti-deuterons and anti-helium nuclei can, in principle, exist,
- yet are extremely scarce,
- without requiring a symmetric primordial production.

Scarcity follows from dynamics, not prohibition.

6.3 Perfectly Compensated Aggregates

6.3.1 Structure

Some composite configurations admit **exact cancellation of internal orientations**. This occurs when the Ψ-field circulations of the constituents and the collective envelope are arranged such that their pseudo-scalar contributions sum to zero.

These are **structurally neutral composites**, not merely electrically neutral ones.

6.3.2 Orientational signature

For such aggregates:

$$Q(\text{aggregate}) = 0.$$

6.3.3 Admissibility under conjugation

With no orientation to invert, conjugation produces no new configuration.

6.3.4 Result

These states are **self-conjugate**. No distinct antimatter counterpart exists.

6.3.5 Critical closure

This predicts the existence of **composite matter states with no antimatter analogue**, even though they are built from constituents that individually possess antiparticles.

This is a genuinely new structural prediction.

6.4 Structurally Non-Admissible Compounds

6.4.1 Structure

There exist composite configurations whose internal organization carries a non-zero orientational signature but whose **conjugated realization is mechanically unstable**. In these cases, inversion of orientation disrupts coherence, violates boundary conditions, or destroys the energy minimum.

This instability is a property of the Ψ-field medium, not of the constituents.

6.4.2 Orientational signature

$$Q(\text{compound}) \neq 0.$$

6.4.3 Admissibility under conjugation

$$C(\text{compound}) \text{ is not admissible.}$$

6.4.4 Result

Antimatter is **structurally forbidden** for these states.

6.4.5 Critical closure

This result is decisive:

- it predicts **matter states that cannot have antimatter counterparts even in principle**,
- it shows that antimatter absence can be absolute, not merely statistical,
- it invalidates any assumption of universal matter–antimatter pairing.

6.5 Structural lesson from composite states

Composite and nuclear states demonstrate that antimatter emergence is **not inherited automatically** from constituents. It is governed by **global Ψ-field organization**, orientation, and stability.

This establishes the antimatter criterion as **scale-consistent**: it applies uniformly from elementary excitations to complex aggregates.

7 Canonical Classification Table

The preceding sections establish a complete structural criterion for the emergence of antimatter within Quarkbase Cosmology. The purpose of the canonical classification table is **not** to summarize observations, but to make explicit the **logical outcome** of applying the same rule uniformly across all classes of Ψ-field excitations.

Each entry in the table follows unambiguously from:

- the orientational signature (Q),
- and the mechanical admissibility of the conjugated configuration ($C(X)$).

No phenomenological adjustment is involved.

7.1 Logical construction of the table

For any excitation class X, exactly one of the following is true:

1. $Q(X) = 0$
   $\Rightarrow$ the excitation is self-conjugate.
2. $Q(X) \neq 0$ and $C(X)$ is admissible
   $\Rightarrow$ a distinct antiparticle exists.
3. $Q(X) \neq 0$ and $C(X)$ is not admissible
   $\Rightarrow$ antimatter is structurally forbidden.

This exhausts all possibilities. There are no intermediate or ambiguous cases.

7.2 Canonical classification

State class	Q	C **admissible**	**Outcome**
Charged lepton	$\neq 0$	Yes	Antiparticle exists
Baryon	$\neq 0$	Yes	Antiparticle exists
Meson	$\neq 0$	Yes	Antiparticle exists
Light nucleus	$\neq 0$	Yes	Anti-nucleus exists
Neutrino ($N = 1$)	0	Auto	No distinct antiparticle
Electromagnetic mode	0	Auto	No antifotón
Non-admissible compound	$\neq 0$	No	Antimatter forbidden

7.3 Why this table is not optional

This table is **forced** by the framework.
Once the Ψ-field is taken as a real medium:

- orientation becomes a physical property,
- stability becomes a mechanical constraint,
- and conjugation becomes a conditional operation.

Under these conditions:

- the existence of antimatter **cannot** be universal,
- self-conjugate states **must** exist,
- and antimatter-forbidden states **must** exist.

Any theory that assumes a one-to-one pairing between matter and antimatter for all excitations implicitly assumes either:

- an abstract vacuum,
- or an exact global symmetry of the medium.

Quarkbase Cosmology assumes neither.

7.4 Resolution of long-standing inconsistencies

The canonical table resolves, in a single framework:

- why positrons and antiprotóns exist,
- why neutrinos and photons do not require distinct antiparticles,
- why anti-nuclei are possible but extremely rare,
- and why some composite states admit no antimatter analogue at all.

No separate mechanisms are needed for different sectors.

7.5 Predictive role of the table

The table is not merely classificatory. It is **predictive**.
Given any newly proposed excitation or bound state, its antimatter status can be determined **a priori** by evaluating:

1. its orientational signature Q,
2. the stability of its conjugated pattern.

This is a concrete, falsifiable procedure.

7.6 Conceptual closure

With this classification, antimatter is no longer a mysterious global imbalance, but a **filtered structural outcome** of the Ψ-field.

The table is therefore the **structural backbone** of the theory's antimatter sector.

8 Falsifiable Predictions

The Quarkbase Criterion of Antimatter is not an interpretative overlay; it makes **direct, falsifiable predictions** that distinguish it sharply from Standard Model–based cosmology and particle ontology. These predictions follow necessarily from the structural role of orientation and mechanical admissibility in the Ψ-field.

8.1 Absence of antifotón and structurally distinct antineutrino

Prediction

No antifotón and no structurally distinct antineutrino exist.

Rationale

Electromagnetic modes and the $N = 1$ neutrino are self-conjugate excitations with

$$Q = 0.$$

Conjugation does not generate a new stable configuration.

What would falsify this

- Observation of a propagating electromagnetic excitation that:
  - is not reducible to polarization/helicity,
  - carries identical dispersion relations,
  - but annihilates with ordinary photons as a distinct entity.
- Detection of a neutrino excitation that:
  - cannot be mapped to the same Ψ-field mode under interaction reversal,
  - and requires a separate structural degree of freedom.

Such observations would directly contradict the framework.

8.2 Selective existence of anti-nuclei

Prediction

Only **structurally admissible** anti-nuclei can exist. Anti-deuteron, anti-helium-3, and anti-tritium are permitted; heavier or structurally frustrated anti-nuclei are forbidden.

Rationale

Light nuclei retain a global orientational signature ($Q \neq 0$) and admit stable conjugates. More complex aggregates may fail the admissibility test under orientation inversion.

What would falsify this

- Robust detection of anti-nuclear species predicted to be structurally non-admissible.
- Systematic detection of arbitrarily heavy anti-nuclei with no suppression correlated to structure.

Either result would invalidate the mechanical filtering mechanism.

8.3 Mode-dependent matter–antimatter asymmetry

Prediction

Matter–antimatter asymmetry is **mode-dependent**, not universal.

Leptons, baryons, mesons, and nuclei should exhibit **different survival and production ratios**, reflecting their distinct coupling to the surrounding Ψ-field.

Rationale

The asymmetry originates in differential stability and dissipation between P and P^*, not in a single global CP-violating parameter.

What would falsify this

- Discovery of a single universal asymmetry parameter governing all sectors.
- Exact proportionality of matter–antimatter ratios across all excitation classes.

8.4 Leptonic primacy in asymmetry transfer

Prediction

Asymmetry arises first in leptonic modes and is subsequently transferred to baryonic and nuclear sectors.

Rationale

Leptonic excitations couple more directly to the background Ψ-field and respond earlier to orientational bias. Baryons inherit this bias through composite formation.

What would falsify this

- Evidence that baryonic asymmetry arises independently of leptonic asymmetry.
- Observation of baryon-dominated asymmetry in regimes where leptonic asymmetry is absent.

8.5 Existence of matter states with no antimatter counterpart

Prediction

There exist stable matter states for which antimatter is **forbidden in principle**, not merely unobserved.

These correspond to $Q \neq 0$ configurations whose conjugates are mechanically unstable.

Rationale

Mechanical inadmissibility under conjugation is a structural property of the Ψ-field.

What would falsify this

- Demonstration that every stable excitation admits a stable conjugate.
- Empirical confirmation of antimatter counterparts for states predicted to be forbidden.

8.6 Experimental posture of the theory

The Quarkbase antimatter framework does **not** predict dramatic new particles on demand. Instead, it predicts **systematic absences**, selective existence, and structured asymmetries.

This is a strength, not a weakness.

A single confirmed violation of any prediction above would require revision or abandonment of the criterion.

8.7 Summary of falsifiability

The theory is falsifiable because it asserts:

- explicit non-existence claims,
- structural constraints independent of cosmological history,
- and sector-specific asymmetry behavior.

This places it outside the category of unfalsifiable reinterpretations.

9 Conclusions

This work establishes a **structural and medium-based criterion** for the existence of antimatter within the framework of Quarkbase Cosmology. Antimatter is shown to be neither a universal companion to matter nor a remnant of an assumed primordial symmetry. Instead, it emerges conditionally from the physical properties of the Ψ-field.

The central result is a simple but powerful law: a distinct antiparticle exists if and only if an excitation of the Ψ-field carries a non-zero orientational signature and its conjugated configuration is mechanically admissible. This criterion requires no appeal to Big Bang cosmology, no imposed CPT symmetry, and no fine-tuned CP-violating parameters.

Applying this law systematically yields a coherent and unified picture:

- charged leptons and baryons admit antiparticles as orientation-inverted realizations of the same structures,
- neutrinos and electromagnetic modes are intrinsically self-conjugate,
- light anti-nuclei are structurally allowed but dynamically rare,
- and certain composite states admit no antimatter counterpart in principle.

The framework resolves long-standing inconsistencies in the standard matter–antimatter narrative by reframing asymmetry as a **selection rule of a physical medium**, rather than as a historical anomaly requiring special initial conditions.

Equally important, the theory is falsifiable. It makes explicit claims about non-existence, selective admissibility, and mode-dependent asymmetry that can be tested experimentally. A single robust violation would necessitate revision or rejection of the criterion.

In Quarkbase Cosmology, antimatter is no longer a mystery of origins. It is a consequence of structure.

Bibliography

References

[1] C. Omenaca Prado, *Genesis Quarkbase: A New Genesis for Physics*, Zenodo (2025). doi:10.5281/zenodo.17925340.

[2] C. Omenaca Prado, *The Leptonic Spectrum of the* Ψ*-Field*, Zenodo (2025). doi:10.5281/zenodo.17957261.

[3] C. Omenaca Prado, *Neutrino Oscillations as Internal Mode Interference in Quarkbase Cosmology*, Zenodo (2025). doi:10.5281/zenodo.17930306.

[4] P. A. M. Dirac, *A Theory of Electrons and Protons*, Proceedings of the Royal Society A **126**, 360 (1930).

[5] A. D. Sakharov, *Violation of CP Invariance, C Asymmetry, and Baryon Asymmetry of the Universe*, JETP Letters **5**, 24 (1967).

[6] R. F. Streater and A. S. Wightman, *PCT, Spin and Statistics, and All That*, Princeton University Press (2000).

[7] G. Baur et al., *Antimatter Production in Relativistic Heavy-Ion Collisions*, Physics Reports **364**, 359–450 (2002).

[8] M. Aguilar et al. (AMS Collaboration), *Search for Antihelium in Cosmic Rays*, Physical Review Letters **117**, 091103 (2016).