The Nuclear ‘mass’ defect as a Topological Property of Ether Confinement in Quarkbase Cosmology

Carlos Omeñaca Prado

November 2025

Abstract

This work develops a geometric and topological reformulation of nuclear structure within the framework of Quarkbase Cosmology. In this model, nuclear properties do not arise from fundamental forces, intrinsic mass, or interaction mediators, but from the compact packing of quarkbases and from the stationary behavior of the ether's pressure field Ψ.

Two structural quantities are introduced: the total displaced volume V_D and the gradient-carrying volume V_∇, whose ratio defines the confinement fraction f_{conf}. These magnitudes enable a unified description of nuclear phenomena—‘mass’ defect, binding energy, isotopic stability, magic numbers, and upper atomic limits—using only geometric and topological principles.

In this framework, the classical ‘mass’ defect is fundamentally a *volume defect*: a deficit of accessible ether volume caused by the emergence of stationary-gradient confinement pockets. The cuarquic nuclear axiom,

$$\Delta P = \beta_{\text{nucl}} V_\nabla,$$

identifies the nuclear ‘mass’ defect as the direct consequence of the three-dimensional topology of these confined ether domains. The stability criterion,

$$\frac{dV_\nabla}{dN_q} > v_q,$$

provides the necessary condition for a nucleus to admit a stationary Ψ-field solution.

Together, these results eliminate the need for interaction-based descriptions of nuclear matter and establish a fully geometric account in which nuclear stability and binding arise from the topological structure of quarkbase packing and the stationary dynamics of the ether.

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1 Introduction

Conventional nuclear physics attributes binding energy to the action of internal forces between nucleons, mediated by fields or virtual particles and dependent on effective interaction models. Within the framework of Quarkbase Cosmology, such a description is unnecessary. In this framework:

- no fundamental forces exist,
- mass does not exist as an intrinsic property,
- no mediators exist,
- and all dynamics emerge exclusively from the compact geometry of quarkbases and from the behavior of the pressure field Ψ in an ideal, frictionless ether ($\mu = 0$).

In Quarkbase Cosmology, the classical "mass defect" is fundamentally a volume defect: a reduction in the accessible ether volume caused by confinement into stationary-gradient pockets. This geometric volume deficit is the primary structural origin of the energetic quantity traditionally interpreted as missing mass.

From this perspective, the so-called nuclear "mass defect" does not represent an energetic loss nor a quantitative anomaly, but rather a geometric phenomenon. Its origin lies in the creation of internal regions of the ether in which the pressure field acquires stationary gradients imposed by the quarkbase lattice that forms the nucleus.

This work develops a geometric characterization of the nuclear 'mass' defect—the operational equivalent of the classical mass defect—based exclusively on:

- the packing architecture of quarkbases,
- the topology induced in the confined ether,
- and the redistribution of the Ψ field within confinement regions.

This approach makes it possible to derive a structural expression for the 'mass' defect and, from it, a general criterion for nuclear stability within the cuarquic framework.

2 Cuarquic Architecture of the Electron, Proton, and Nucleons

The elementary structure of matter in Quarkbase Cosmology is grounded in compact configurations of quarkbases, understood as indivisible volumetric units that displace and deform the ether, generating the pressure field Ψ. The effective properties of particles do not arise from intrinsic attributes, but from the geometry and topology of these compact arrangements.

2.1 Electron

The electron corresponds to the minimal stable configuration in which the Ψ field admits a stationary solution. It is composed of:

- a central quarkbase,
- surrounded by twelve quarkbases arranged in an icosahedral shell.

This spherical structure of thirteen elements constitutes the first compact configuration capable of maintaining a static and symmetric pressure gradient. Its stability arises from the geometric equivalence of the tangencies and from the uniformity of ether confinement within the interstitial regions of the shell.

2.2 Proton

The proton consists of thirty-six quarkbases distributed in a frequency-2 spherical mesh, in which all elements are tangent to a common imaginary surface. This dense distribution generates a significantly larger number of confined ether regions, increasing the associated gradient volume and, consequently, the effective cuarquic weight of the system.

In this model, mass does not exist as a fundamental property: the difference in weight between the electron and the proton arises exclusively from:

- the total number of quarkbases involved,
- the degree of compression of the displaced ether,
- and the topology of the confined regions induced by the nuclear geometry.

2.3 Neutrons and nucleons

The neutron, and more generally any nucleon, is described by analogous compact configurations determined by the three-dimensional distribution of quarkbases and by the ether regions trapped between them. The effective properties of a nucleon (cuarquic weight, stability, interaction with other configurations) depend solely on:

- the number of quarkbases,
- the geometric form of the packing,
- and the structure of the Ψ field within the internal confinement regions.

Within this framework, the conventional notion of “nuclear forces” is replaced by the redistribution of confined ether and by the reorganization of the Ψ field when compact configurations combine or separate.

3 Total Displaced Volume and Gradient-Carrying Volume

Nuclear structure in Quarkbase Cosmology is characterized by the manner in which quarkbases displace the ether and generate internal confinement regions where the pressure field Ψ develops stationary gradients. To describe this architecture systematically, two fundamental quantities are introduced: the total displaced volume and the gradient-carrying volume.

3.1 Total displaced volume V_D

Each quarkbase constitutes a perfectly compact volumetric unit that excludes the ether from its interior. For a nucleus composed of N_q quarkbases, the total displaced ether volume is defined as:

$$V_D = N_q \, v_q, \tag{1}$$

where v_q is the intrinsic volume of a quarkbase.

This quantity measures the spatial extent of the ether expelled by the presence of the nucleus and establishes the general scale of medium compression. It is a purely geometric measure, independent of any dynamical consideration.

3.2 Confined ether regions

The presence of multiple quarkbases in contact generates domains of ether enclosed between compact surfaces. A **confined region** is defined as any ether volume that simultaneously satisfies all of the following:

1. It is completely bounded by quarkbases in all three spatial dimensions.
2. It exhibits a stationary gradient of the Ψ field, resulting from the geometric packing.
3. It cannot relax outward due to the absence of sufficiently open communication paths to the exterior.

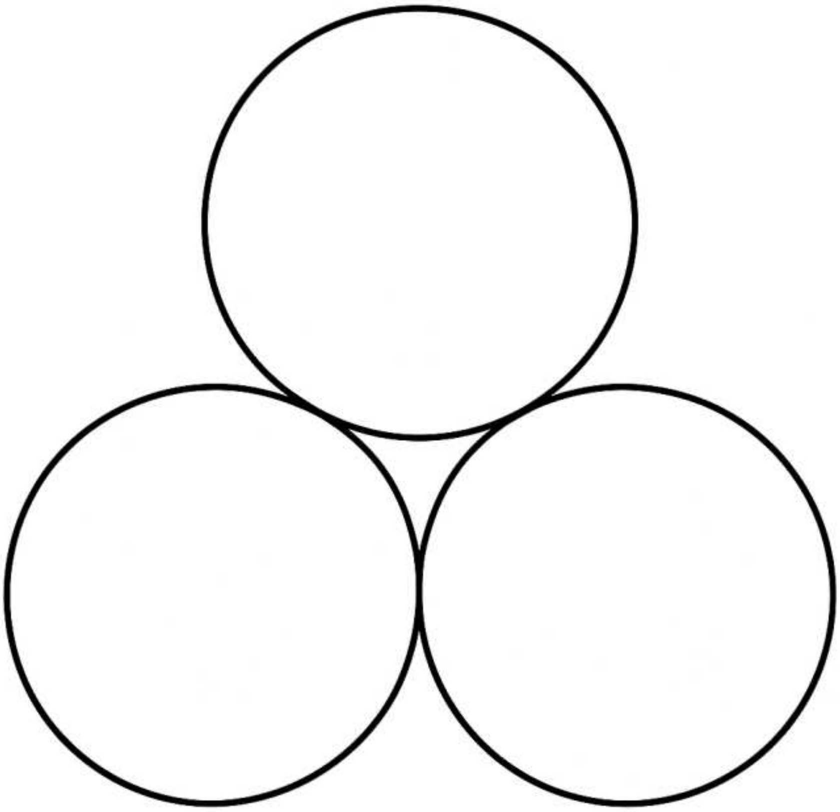

Figure 1: Minimal confined-ether pocket generated by three mutually tangent quarkbases. This 2D analogue represents the elementary topological unit from which the gradient-carrying volume V_∇ arises.

These regions constitute the internal interstices or “pockets” that naturally arise in dense three-dimensional configurations.

In the cuarquic model, the energy associated with a nucleus does not depend on an interaction between nucleons, but on the distribution and number of these confined domains.

3.3 Gradient-carrying volume V_∇

The dynamically relevant contribution comes exclusively from the volumes of ether in which the pressure field maintains gradients imposed by the compact geometry. The **gradient-carrying volume** is defined as:

$$V_\nabla = \sum_{k=1}^{N_{\text{conf}}} V_k, \tag{2}$$

where:

- N_{conf} is the number of confined regions in the nucleus,
- V_k is the volume of the k-th confined domain.

This quantity describes the degree of topological activity of the ether within the nucleus and is responsible for the effective cuarquic weight contribution.

3.4 Confinement fraction f_{conf}

An adimensional measure that synthesizes the efficiency of packing is the **confinement fraction**:

$$f_{\text{conf}} = \frac{V_\nabla}{V_D}. \tag{3}$$

- High values of f_{conf} indicate that a significant portion of the displaced ether becomes trapped in domains with stationary gradients, favoring stable configurations.
- Low values suggest less efficient packing and are typically associated with structural instabilities or with configurations that do not admit a stationary Ψ field.

This fraction will serve as the central structural variable for determining nuclear stability in subsequent sections.

4 Cuarquic Nuclear Axiom

The phenomenon conventionally referred to as the *nuclear mass defect* is interpreted, within Quarkbase Cosmology, as a direct manifestation of the reorganization of the ether into confined regions where the pressure field Ψ develops stationary gradients. From this perspective, the effective cuarquic weight contribution of the nucleus does not depend on intrinsic properties of the nucleons, but on the geometric and topological structure generated by the packing of quarkbases.

Within this framework, the following fundamental principle is introduced.

4.1 Cuarquic Nuclear Axiom

The nuclear 'mass' defect ΔP arises from the total volume of ether trapped in confined regions where the pressure field Ψ maintains a stationary gradient imposed by the internal geometry of the nucleus.

Thus, the nuclear "mass" defect may be expressed more precisely as a volume defect: the total ether volume forced into confined domains where the Ψ field is topologically unable to relax.

In its most general form, this principle is expressed as:

$$\Delta P = \beta_{\text{nucl}} \, V_\nabla, \tag{4}$$

where:

- V_∇ is the gradient-carrying volume defined in the previous section,
- β_{nucl} is a coefficient representing the effective rigidity of the ether within such regions, whose magnitude depends exclusively on the local structure of the Ψ field.

In nuclear configurations where the confined regions have similar sizes and gradients, the axiom admits a simplified form:

$$\Delta P \propto N_{\text{conf}}, \tag{5}$$

where N_{conf} denotes the number of internal ether domains subjected to geometric confinement.

4.2 Structural interpretation

This axiom establishes that the cuarquic weight contribution of the nucleus does not originate from interactions between nucleons nor from concepts such as potential energy or intrinsic mass. Instead, it arises exclusively from the quantity and distribution of confined ether regions, whose degree of compression and gradient determines the stationary configuration of the pressure field Ψ.

The classical notion of binding energy is thus replaced by a purely geometric description: the internal structure of the nucleus defines the topology of the confined ether, and this topology sets the value of the 'mass' defect.

5 Cuarquic Stability Rule for Atomic Nuclei

The stability of a nucleus in Quarkbase Cosmology is manifested only when the pressure field Ψ admits a stationary configuration compatible with the distribution of quarkbases. The conventional criterion that associates nuclear stability with the existence of attractive forces between nucleons is replaced, in this framework, by a purely geometric principle.

The analysis of the ether's confined regions allows the derivation of the following structural result.

5.1 Cuarquic Stability Principle

A nucleus is stable when, as the total number of quarkbases increases, the gradient-carrying volume V_∇ grows more rapidly than the total displaced volume V_D.

Formally, the stability condition can be expressed as:

$$\frac{dV_\nabla}{dN_q} > \frac{dV_D}{dN_q} = v_q, \tag{6}$$

or, by explicitly introducing the geometric scale of the nucleus,

$$\frac{dV_\nabla}{dN_q} > \frac{v_q}{R_{\text{núcleo}}}. \tag{7}$$

This inequality identifies the geometric origin of nuclear stability: the incorporation of additional quarkbases must generate a sufficient number of new confined regions to compensate for the increase in displaced volume.

5.2 Conceptual interpretation

From this perspective:

- If the addition of nucleons produces a significant increase in confined regions—i.e., if it raises V_∇ efficiently—then the resulting configuration tends toward a stationary solution of the Ψ field, and the nucleus is stable.
- Conversely, if the incorporation of new quarkbases merely increases the displaced volume without generating additional confined regions, the system loses its ability to sustain a stationary Ψ field. In such cases, the nucleus becomes unstable or fails to admit a consistent cuarquic configuration.

5.3 Relation to classical binding energy

This geometric rule naturally reproduces the experimentally observed behavior:

- in light nuclei, the binding energy per nucleon increases with the total number of quarkbases,
- it reaches a maximum in dense configurations such as iron-56,
- and it decreases in heavier nuclei due to the reduced efficiency of additional confinement.

Within the cuarquic model, this phenomenon is interpreted as a direct consequence of how the nuclear structure modifies the volume V_∇, without invoking nuclear forces, effective potentials, or phenomenological adjustment terms.

6 Magic Numbers: A Cuarquic Interpretation

The so-called *magic numbers* in nuclear physics—2, 8, 20, 28, 50, 82, 126—are traditionally associated with particularly stable nuclei, whose structure is interpreted in the classical framework through the nuclear shell model, quantized orbitals, and paired spins. Such explanations rely on potential approximations and phenomenological adjustments.

In Quarkbase Cosmology, stability does not arise from quantized shells or fundamental interactions, but from the three-dimensional geometry of quarkbases and from the topology of the confined ether regions induced by their packing. This makes it possible to reinterpret magic numbers through a purely geometric criterion.

6.1 Geometric Principle of the Magic Numbers

Magic numbers correspond to configurations in which the three-dimensional quarkbase lattice reaches a **local super-packing state**, characterized by:

1. a relative maximum in the gradient-carrying volume V_∇,
2. a highly symmetric distribution of confined regions,
3. and a packing density that favors stationary solutions of the Ψ field.

At these points, the addition or removal of quarkbases breaks the internal symmetry and significantly reduces confinement efficiency, leading to:

- an abrupt decrease in f_{conf},
- and consequently, reduced nuclear stability.

6.2 Structural manifestations

1. Light nuclei

- Helium-4 constitutes the first highly symmetric cuarquic configuration.
- Its closed structure maximizes V_∇ relative to its size.

This explains its high stability without invoking spins or orbitals.

2. Medium-mass nuclei

- Configurations such as carbon-12 and oxygen-16 exhibit dense three-dimensional meshes, where geometric symmetry induces a large number of confined domains.
- As the total number of quarkbases increases, the packing retains an efficient growth of V_∇, reproducing the experimentally observed trend of increasing stability.

3. Structural maximum in iron-56

- In iron-56, the topological efficiency of the packing reaches a local maximum.
- The ratio $f_{\text{conf}} = V_\nabla / V_D$ approaches its optimal value.

This result matches the position of the maximum stability observed experimentally.

4. Heavy nuclei

- For larger configurations, three-dimensional packing becomes less efficient.
- Increasing the number of quarkbases raises the displaced volume more rapidly than the additional gradient volume generated.

This leads to reduced stability, consistent with the behavior of heavy nuclei.

6.3 General cuarquic interpretation

Magic numbers thus emerge as:

> **the three-dimensional quarkbase configurations that maximize the ratio between the gradient-carrying volume and the total displaced volume, thereby ensuring stationary solutions of the Ψ field.**

This formulation unifies all cases—light, medium, and heavy nuclei—under a single geometric principle, without requiring additional mechanisms.

7 The ‘mass’ defect as the Shadow of Nuclear Topology

The phenomenon traditionally known as the *mass defect* in conventional nuclear physics is described as the difference between the total mass of a nucleus and the sum of the masses of its free nucleons, and is interpreted as a measure of the binding energy that holds the system together. In Quarkbase Cosmology, this phenomenon is reinterpreted from a completely different perspective, based exclusively on geometric properties of the ether and of the pressure field Ψ.

7.1 Geometric origin of the ‘mass’ defect

The effective cuarquic weight contribution of the nucleus arises from volumes of ether subjected to geometric confinement, where the Ψ field maintains stationary gradients. These internal domains—described in terms of V_∇—constitute the determining structure of the system’s internal energy.

Equivalently, the ‘mass’ defect is a volume defect: the deficit of free ether volume resulting from the creation of high-curvature confinement pockets.

Within this framework:

$$\Delta P = \beta_{\text{nucl}} V_\nabla, \tag{8}$$

which establishes that the ‘mass’ defect is a direct function of the degree of ether confinement and of the intensity of the internal gradients, without reference to attractive forces, intrinsic masses, or interaction mediators.

7.2 Topological interpretation

The ‘mass’ defect reflects the three-dimensional topology generated by the quarkbase packing inside the nucleus. In particular:

- the number of confined regions,
- their connectivity,
- and the geometry of the ether pockets,

determine the stationary structure of the Ψ field and, therefore, the magnitude of V_∇.

Thus, the ‘mass’ defect may be understood as **a topological invariant associated with the internal architecture of the nucleus**: geometric configurations of higher topological complexity lead to a larger gradient-carrying volume and, consequently, to a larger ‘mass’ defect.

From this perspective, the ‘mass’ defect is topologically a volume defect, quantifying how much ether is geometrically sequestered into non-relaxable regions.

7.3 Physical consequences

This formulation provides a general reinterpretation of nuclear binding energy:

- it is not a “potential” between nucleons,

- nor a quantity associated with virtual particles,
- but the measure of the work required to modify the topology of the confined ether in a stable configuration.

During nuclear stabilization, the internal energy does not arise from interactions between discrete components, but from the geometric cost of reorganizing the confined ether regions to form a stationary solution of the Ψ field.

7.4 Conceptual synthesis

In Quarkbase Cosmology:

> **the 'mass' defect is the operational manifestation of the three-dimensional topology of the ether confined within the nucleus.**

This perspective eliminates the need to postulate nuclear forces, intrinsic masses, or strong interaction, and enables a unified description of nuclear structure and stability based exclusively on the ether pressure field and on the geometry of quarkbases.

8 Immediate Consequences and Predictions

The formalism developed in the preceding sections—based on the relationship between the gradient-carrying volume V_∇, the displaced volume V_D, and the three-dimensional architecture of the nucleus—allows the derivation of a set of direct physical consequences. These consequences require no supplementary hypotheses or phenomenological adjustments and constitute structural predictions of Quarkbase Cosmology.

8.1 Isotopic stability line

The stability of an isotope is determined by the variation of V_∇ when modifying the total number of quarkbases in the nucleus.

The stability criterion

$$\frac{dV_\nabla}{dN_q} > \frac{dV_D}{dN_q} \tag{9}$$

identifies which nuclear configurations admit a stationary Ψ field. Accordingly, the isotopic stability line can be interpreted as the set of configurations in which:

- the number of confined regions increases sufficiently to compensate for the geometric expansion of the nucleus, and
- the confinement fraction f_{conf} remains within an interval compatible with stationary solutions.

8.2 Binding energy per nucleon

The well-known pattern of the experimental binding-energy curve—rapid growth in light nuclei, a maximum near iron, and a decline in heavy nuclei—arises naturally from the evolution of f_{conf}:

- in light nuclei, the addition of quarkbases generates numerous new confined regions, efficiently increasing V_∇;
- in medium-mass nuclei, the configurations reach optimal packing with a relative maximum in f_{conf};
- in heavy nuclei, packing efficiency decreases, and the increase in V_D outpaces the increase in V_∇, reducing stability.

This description requires no nuclear forces or effective potentials, since binding energy emerges directly from the topology of the confined ether.

8.3 Upper limit of the atomic number

The formalism implies the existence of a maximum number of quarkbases for which a nucleus can sustain a stationary Ψ field.

When:

$$\frac{dV_\nabla}{dN_q} \to 0, \tag{10}$$

the system ceases to generate additional confined regions, and the structure loses the ability to maintain a stationary Ψ field.

This criterion establishes a theoretical upper limit for the atomic number, determined solely by the geometry of three-dimensional packing rather than by considerations of quantum stability or electromagnetic repulsion.

8.4 Instability transitions (alpha and beta decays)

Radioactive transitions are reinterpreted as processes of reorganizing the confined ether:

- **Alpha decay:** occurs when the expulsion of a compact subconfiguration (typically a helium-4 nucleus) increases the confinement efficiency of the residual configuration—that is, when the detachment increases the f_{conf} of the daughter nucleus.
- **Beta decay:** arises when the internal reconfiguration of quarkbases enables a more efficient packing by correcting a mismatch between the global geometry and the local topology of confinement. The process adjusts the number of quarkbases distributed between protons and neutrons without modifying N_q, but optimizes V_∇.

In both cases, the final stability depends exclusively on the new distribution of confined regions and on the resulting stationary configuration of the Ψ field.

8.5 Cuarquic fusion and fission

In fusion and fission reactions, the central criterion remains the evolution of V_∇ before and after the process.

- **Fusion** is energetically favorable when the union of two quarkbase clusters produces a structure with a higher confinement fraction than the sum of the original configurations.
- **Fission** occurs when splitting the nucleus yields subsets with greater topological efficiency than the original configuration.

The energy released in both cases corresponds to the variation in gradient-carrying volume, not to a nuclear interaction between discrete components.

9 Conclusion

The analysis developed in this work establishes a complete reformulation of nuclear structure and stability within the framework of Quarkbase Cosmology. In this model, the internal dynamics of the nucleus do not rely on fundamental forces, intrinsic mass, or mediated interactions, but on the geometry of quarkbase packing and on the response of the ether's pressure field Ψ that surrounds them.

The introduction of the gradient-carrying volume V_∇ and of the confinement fraction $f_{\text{conf}} = V_\nabla / V_D$ enables a uniform characterization of all nuclear phenomena—'mass' defect, binding energy, isotopic stability, and structural limits—through purely geometric and topological principles.

The cuarquic nuclear axiom,

$$\Delta P = \beta_{\text{nucl}} V_\nabla, \tag{11}$$

provides a direct description of the 'mass' defect as the consequence of the three-dimensional reorganization of the confined ether into regions with stationary gradient. This formulation eliminates the need to postulate internal interactions, effective potentials, or binding mechanisms, replacing their role with a single structural quantity derived from the architecture of the nucleus.

The resulting nuclear stability rule,

$$\frac{dV_\nabla}{dN_q} > v_q, \tag{12}$$

identifies the necessary condition for a set of quarkbases to admit a stationary solution of the Ψ field, thereby providing a general criterion for the existence of stable nuclei and for the emergence of upper limits on the atomic number.

Additionally, the reinterpretation of magic numbers as configurations that maximize ether-confinement efficiency establishes a bridge between classical experimental phenomena and the three-dimensional geometry of quarkbases, without invoking quantum-shell concepts or phenomenological adjustments.

Taken together, these results integrate nuclear physics into a single conceptual framework based exclusively on:

- the compaction of quarkbases,

- the topology of confined ether regions,
- and the stationary dynamics of the pressure field Ψ.

Stability, binding energy, and 'mass' defect thus emerge as geometric properties of nuclear structure, offering a unified alternative—free from additional assumptions—to the traditional description of matter.

In its most fundamental description, the nuclear "mass" defect is a volume defect: a measure of the ether volume immobilized by nuclear topology.

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