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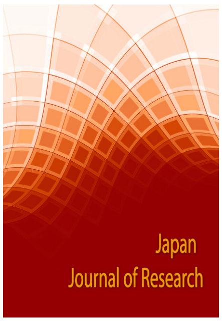


# Atomic Atrophy Hypothesis for Inducing an Implosive Nuclear Structural Collapse with an Ultra-High Attractive Effect: Selective Removal of a Critical Neutron from the Symmetric Backbone Configuration of a Highly Cohesive Atomic Nucleus

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## Abstract

*This study proposes a theoretical framework for investigating the response of atomic nuclei to extreme structural perturbations through the hypothesis of a Critical Nucleon, defined as a nucleon whose contribution to the collective structural stability of the nucleus is greater than that of the remaining nucleons. The proposed framework suggests that the removal of such a nucleon may, under specific structural conditions, trigger a collective reorganization of the nuclear structure that differs qualitatively from conventional nuclear responses.*

*To examine this hypothesis, the study introduces a new theoretical quantity termed the Structural Cohesion Function (Φ) as an indicator of the structural contribution of individual nucleons to nuclear stability. A mathematical framework consisting of axioms, definitions, and preliminary propositions is developed to relate neutron separation energy and collective nuclear structure. The study further proposes the existence of a Critical Structural Threshold, beyond which the nucleus undergoes a structural phase transition into a different collective configuration. Several theoretical predictions are presented together with a validation roadmap based on nuclear shell-model calculations, mean-field approaches, and advanced numerical simulations.*

*In addition, the study discusses an exploratory phenomenological framework for describing possible consequences of such structural transitions, emphasizing that these extensions go beyond established nuclear physics and should be regarded as speculative hypotheses requiring verification through computational modeling and future experimental investigation. The proposed framework is intended as a falsifiable research program that introduces new structural descriptors for nuclear stability and provides a basis for further theoretical and computational studies in nuclear physics.*

## Introduction

The central philosophical motivation underlying this work is based on the concept of Absolute Reverse Symmetry, which seeks the theoretical counterpart—or inverse mirror—of conventional nuclear fission. While nuclear fission produces divergence, explosive energy release, and extremely high temperatures, this study explores the possibility of an inverse nuclear process characterized by structural contraction, inward energy concentration, and a corresponding cooling behavior.

The proposed framework is inspired by an analogy from structural engineering. Just as a complex architectural structure may rely on one or several primary load-bearing columns whose removal causes the collapse of the entire building, this work hypothesizes that certain highly cohesive atomic nuclei may possess a Nuclear Backbone Configuration—a small set of geometrically critical nucleons that collectively sustain the structural integrity of the nucleus.

Within this hypothesis, the selective removal of one of these critical nucleons, particularly a neutron occupying a structurally dominant position, may trigger a spontaneous and collective nuclear structural collapse rather than the conventional fragmentation associated with nuclear fission. The study investigates this possibility from a theoretical perspective and proposes a conceptual framework for identifying such critical structural configurations and evaluating their potential consequences.

## General Research Hypothesis

The central concept of this study originates from an analogy with structural engineering. In stable atomic nuclei, particularly light nuclei,

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neutrons and protons exist in nearly balanced numbers, and each neutron contributes to the overall stability of the nucleus by mitigating the electrostatic repulsion between positively charged protons through the strong nuclear interaction. In this sense, certain nucleons may play a structural role analogous to the primary load-bearing elements of an engineered structure.

Based on this analogy, the present work explores the theoretical possibility of inducing nuclear implosion—a term conventionally used to describe an inward-directed compression of nuclear material—through the selective removal of one or more structurally critical nucleons. Unlike conventional nuclear fission, the proposed mechanism hypothesizes a collective inward structural reorganization of the nucleus initiated by disruption of its internal structural backbone.

The proposed research framework consists of four independent theoretical hypotheses:

- **Hypothesis I – Critical Nucleon Hypothesis:** Certain nuclei may contain one or more nucleons whose structural contribution to collective nuclear stability is significantly greater than that of neighboring nucleons. Their sudden removal may initiate a disproportionate structural response.
- **Hypothesis II – Atomic Atrophy (Nuclear Structural Collapse) Hypothesis:** Atomic atrophy is defined as a rapid internal collapse of the collective nuclear structure resulting from the removal of a structurally critical nucleon or nucleon cluster. Under this hypothesis, the nucleus reorganizes into a substantially different structural configuration without conventional nuclear fission necessarily being the dominant mechanism.
- **Hypothesis III – Anomalous Attractive Interaction Hypothesis:** If nuclear structural collapse occurs, previously unrecognized mechanisms of momentum or energy redistribution may emerge. The present study explores the speculative possibility that such processes could manifest as an effective attractive interaction whose characteristics differ fundamentally from classical gravity. This hypothesis is proposed as a theoretical extension rather than a consequence of established physical laws.
- **Hypothesis IV – Extreme Cooling Hypothesis:** The proposed structural transition may be accompanied by an exceptionally large localized reduction in thermal energy. This possibility remains entirely hypothetical and is presented as a prediction requiring independent theoretical modeling and experimental verification.

Each of these hypotheses represents an independent scientific proposition and therefore requires its own mathematical formulation, physical justification, and experimental validation.

From the standpoint of established nuclear physics, no currently accepted theory predicts that the removal of a neutron can produce gravitational collapse or an implosive attractive explosion. Nuclear dynamics are governed primarily by quantum mechanics and the strong nuclear interaction rather than by classical gravitational forces. Consequently, the present work should be regarded as an exploratory theoretical framework intended to formulate testable predictions rather than as a claim derived from existing physical theory.

If the proposed Atomic Atrophy Hypothesis is valid, one possible theoretical consequence would be the emergence of collective mechanisms of energy or momentum redistribution that differ qualitatively from known nuclear reactions. Such behavior could produce previously unobserved physical phenomena worthy of future theoretical and experimental investigation.

Similarly, any proposal involving the emergence of a new attractive interaction cannot presently be derived from established nuclear physics. Rather, it constitutes a speculative theoretical extension whose validity would require a substantially higher burden of mathematical and experimental proof.

The principal scientific question addressed by this study can therefore be formulated as follows:

***Do certain nuclei contain structurally critical nucleons [1] whose contribution to collective nuclear stability is significantly greater than that of surrounding nucleons, such that disturbing them may trigger a collective structural transition within the nucleus?***

This question is scientifically legitimate because modern nuclear physics recognizes that many nuclear properties emerge from collective many-body interactions rather than from isolated particles.

## Critical Nuclear Core

The present work further hypothesizes that structural stability may not depend upon a single nucleon but rather upon a small ensemble of mutually coupled nucleons forming a Critical Nuclear Core. This core may consist of three, four, or several nucleons acting collectively to preserve the structural coherence of the nucleus. Under such a scenario, removal of an individual nucleon may produce only a limited perturbation, whereas disruption of the collective core could initiate a significantly larger structural transition.

This interpretation is more consistent with the current understanding of nuclear many-body systems, where collective behavior frequently dominates individual particle dynamics.

Modern nuclear physics already contains several concepts related to collective nuclear structure, including the Nuclear Shell Model, Pairing Correlations, Collective Excitation Modes[2], Halo Nuclei, and Nuclear Resonances [3] , However, no established theoretical framework currently defines a Principal Neutron or Critical Nucleon in the sense proposed here. Consequently, the principal scientific contribution of this work may lie in introducing such a concept through a rigorous mathematical definition together with objective criteria that permit its identification.

Accordingly, the central hypothesis of this study may be summarized as follows:

Certain atomic nuclei may possess a critical structural threshold beyond which a sufficiently large perturbation triggers a collective structural transition qualitatively different from conventional nuclear responses. The objective of this research is to identify this threshold, if it exists, through theoretical modeling, numerical simulation, and comparison with available nuclear data.

Within the framework of contemporary nuclear theory, atomic nuclei are understood as quantum many-body systems, and neutrons do not literally function as isolated structural columns in the engineering sense. Nevertheless, nuclear shell structure, pairing interactions, collective correlations, and configuration mixing imply that some nucleons may contribute more significantly to the overall structural stability than others. Therefore, rather than assuming the existence of a "Principal

Neutron," this study proposes that the concept of a Critical Nucleon should be formulated mathematically and evaluated objectively through theoretical and computational analysis.

## Research Objectives: Why Remove a Neutron from the Nucleus? Initial Scientific Challenges

The primary objective of this study is to investigate whether a highly cohesive atomic nucleus can be driven into a fundamentally different structural state through the sudden removal of one or more structurally critical nucleons. More specifically, the research seeks to determine whether certain nuclei possess an internal structural backbone whose disruption initiates a collective nuclear reorganization beyond the conventional response predicted by current nuclear models.

The proposed framework considers the possibility of selecting a highly stable nucleus and subjecting it, under controlled laboratory conditions, to the rapid extraction of a nucleon hypothesized to occupy a structurally dominant position within the nuclear configuration. The central question is whether such a perturbation could induce a collective structural transition characterized by an internally reorganized nuclear state rather than conventional fission or radioactive decay.

This investigation is exploratory in nature and does not assume that the predicted phenomena necessarily occur. Instead, it aims to formulate a mathematically testable theoretical framework capable of identifying structural instability thresholds within highly cohesive nuclei.

### Proposed Nuclear Mechanism

The present hypothesis proposes that the removal of a structurally critical nucleon may destabilize the collective nuclear configuration sufficiently to trigger an internally driven structural collapse or large-scale nuclear reorganization. Unlike ordinary nuclear reactions, the proposed mechanism emphasizes changes in collective structural coherence rather than simple particle emission.

The concept of Atomic Atrophy introduced in this work refers to this hypothetical collective structural transition. It should not be interpreted as an established physical phenomenon but rather as a theoretical construct intended for future analytical and computational investigation.

**Initial Scientific Challenges**

The strongest challenge facing the proposed hypothesis is that no accepted physical theory currently predicts that the sudden removal of a neutron from an atomic nucleus can generate:

- a previously unknown attractive interaction,
- an implosive "Suction" effect,
- or an extreme cooling phenomenon extending beyond the nucleus itself.

At present, no experimental observations or established theoretical models support such processes.

Accordingly, a more scientifically appropriate formulation of the proposed hypothesis is the following:

The removal of a structurally critical nucleon may induce a collective redistribution of energy and momentum within the nuclear many-body system, potentially leading to previously unrecognized structural transition phenomena. Whether such phenomena exist remains an open theoretical question requiring mathematical modeling, numerical simulation, and experimental investigation.

This formulation preserves the central research hypothesis while remaining consistent with the standards of scientific methodology.

## Fundamental Physical Constraints of the Proposed Model

The proposed framework encounters several major challenges arising from well-established principles of modern physics. These limitations do not invalidate the hypothesis but define the theoretical barriers that must be overcome before the model can be considered physically viable.

### The Gravity Constraint

One of the principal obstacles concerns the origin of gravitational attraction.

The proposed hypothesis initially considers whether extreme structural contraction could generate an unusually strong attractive effect. However, according to both Newtonian gravity and General Relativity, gravitational interaction is determined primarily by mass-energy and spacetime geometry rather than by material density or atomic compactness alone.

Consequently, reducing the physical size of an individual atom—even hypothetically to an extremely compact configuration—would not significantly increase its gravitational influence if its total mass remained essentially unchanged.

For example, compressing a uranium atom to an arbitrarily small volume would not transform it into a strong gravitational source. Its gravitational field would remain negligibly small because the total mass involved is microscopic. In contemporary physics, ultra-strong gravitational fields require astronomical masses, such as those associated with neutron stars or black holes, rather than isolated atomic nuclei.

Therefore, any hypothesis predicting an effective attractive interaction generated by nuclear structural collapse cannot presently be explained by conventional gravitational theory and would require an entirely new theoretical mechanism.

### The Thermodynamic Constraint

A second major challenge concerns the interpretation of extreme cooling.

The original hypothesis considers the possibility that nuclear structural collapse may produce an intense cooling effect extending into the surrounding environment. However, within modern thermodynamics, temperature is not treated as an independent substance capable of propagating outward. Instead, cooling simply corresponds to the removal or redistribution of thermal energy.

Furthermore, absolute zero (−273.15 °C) represents the lower thermodynamic limit accessible within current physical theory. No established mechanism allows a single atomic nucleus to generate a propagating macroscopic cooling wave extending beyond its immediate surroundings.

Although nuclear reactions may remove energy through neutrino emission or other weak-interaction processes, these mechanisms cool the emitting system itself rather than producing a large-scale freezing front in the surrounding medium.

Consequently, any prediction involving extraordinary cooling must be regarded as speculative and requires the formulation of a new physical mechanism before it can be considered experimentally testable.

## Nuclear Transmutation Rather than Structural Collapse

A further challenge arises from conventional nuclear reaction theory.

Within established nuclear physics, removing a neutron from an atomic nucleus generally produces a different isotope, whereas changing both proton and neutron numbers leads to nuclear transmutation into another chemical element. Such processes are typically accompanied by radioactive decay, particle emission, or gamma radiation.

Therefore, according to current understanding, nucleon removal modifies the nuclear identity rather than inducing an inward structural collapse of the type proposed in this work.

This distinction represents one of the most important theoretical issues addressed by the present research. The central objective is to investigate whether there exists an additional structural response beyond conventional nuclear transmutation—one governed by collective many-body dynamics rather than solely by changes in nuclear composition.

# Definition of the Critical Nucleon

## Critical Nucleon Hypothesis

The central hypothesis of this study proposes that certain atomic nuclei may contain one or more nucleons whose contribution to the collective structural stability of the nucleus is significantly greater than the average contribution of the remaining nucleons.

The removal of such a nucleon is not hypothesized to necessarily produce conventional nuclear fission. Instead, it may induce a collective structural transition characterized by large-scale reorganization of the nuclear many-body system, including changes in nuclear energy levels, deformation of the nuclear shape, modifications of excitation spectra, and alterations in other collective nuclear properties.

Accordingly, the primary objective of this work is to establish a mathematical framework capable of identifying these Critical Nucleons and evaluating their existence through theoretical modeling, nuclear shell-model calculations, neutron separation-energy data, and numerical simulations.

## Can a Specific Neutron Be Selected?

Within the framework of contemporary nuclear physics, the answer is no.

Current experimental techniques cannot identify or selectively remove an individual neutron from a nucleus in the sense of stating, for example, "Remove neutron number seven." Nucleons inside atomic nuclei are quantum particles described by many-body wave functions rather than localized classical objects with fixed positions or permanent identities.

Consequently, the concept proposed in this work does not refer to a neutron occupying a particular spatial location. Instead, it refers to a nucleon whose structural contribution to the collective stability of the nucleus is objectively greater than that of the remaining nucleons according to a well-defined mathematical criterion.

## Mathematical Definition of the Critical Nucleon

Let

$$E\,(N,Z)$$

denote the total binding energy of a nucleus containing (N) neutrons and (Z) protons.

The structural importance of the (i)-th nucleon may be quantified by introducing a Criticality Index, defined as

$$C_i = |\partial E/\partial n_i|$$

where (ni) represents the occupation or structural contribution of the (i)-th nucleon within the collective nuclear configuration.

Alternatively, a finite-difference formulation may be employed,

$$C_i = \Delta E_i$$

where

represents the change in the total nuclear binding energy resulting from the removal of the (i)-th nucleon.

Accordingly, the Critical Nucleon is defined as the nucleon satisfying

$$C_i = \max\,(C_1, C_2, \ldots, C_n)$$

In other words, the Critical Nucleon is the nucleon whose removal produces the largest structural perturbation in the collective nuclear state according to the selected mathematical criterion.

This definition provides an objective and quantitatively testable characterization of the concept introduced in this study. Unlike the informal notion of a "Principal Neutron," the Critical Nucleon is defined entirely through measurable or computable physical quantities, allowing its existence to be investigated using established nuclear-structure calculations, shell-model analyses, many-body simulations, and experimental separation-energy data.

The proposed definition therefore transforms the concept from a qualitative hypothesis into a mathematically formulated scientific quantity that can be examined, validated, or falsified within the framework of theoretical and computational nuclear physics.

# Selection of Candidate Nuclei: Why Not Choose a Weakly Bound Nucleus?

To investigate the proposed Critical Nucleon Hypothesis, it is first necessary to identify atomic nuclei whose structural organization makes them suitable candidates for examining collective nuclear stability following the removal of a potentially critical nucleon.

Rather than focusing on a single class of nuclei, this study proposes the investigation of four categories of nuclear systems, each possessing distinct structural characteristics that may provide insight into the existence of a critical structural threshold.

## Group I: Closed-Shell (Magic) Nuclei

If the objective is to test the concept of a structural "backbone" within the nucleus, the most suitable candidates are closed-shell (Magic) nuclei, owing to their exceptional structural regularity and stability.

The principal candidates considered in this study are:

- Oxygen-16 ($O^{16}$)
- Calcium-40 ($Ca^{40}$)
- Calcium-48 ($Ca^{48}$)
- Lead-208 ($Pb^{208}$)

These nuclei represent some of the most highly ordered and structurally coherent nuclear systems currently known and therefore provide an appropriate platform for investigating the proposed Nuclear Backbone Configuration (Table 1).

***Table 1.*** *Candidate Double-Magic Nuclei Proposed for Investigation*

| Nuclear Symbol | Isotope | Atomic Number (Z) | Neutron Number (N) | Rationale for Selection |
|---|---|---|---|---|
| O16 | Oxygen-16 | 8 | 8 | Double-magic nucleus exhibiting exceptional structural symmetry and stability. |
| Ca40 | Calcium-40 | 20 | 20 | Double-magic nucleus with one of the most regular nuclear configurations. |
| Ca48 | Calcium-48 | 20 | 28 | Neutron-rich double-magic nucleus extensively studied in nuclear structure physics. |
| Pb208 | Lead-208 | 82 | 126 | The heaviest stable double-magic nucleus and a benchmark system in nuclear physics. |

**Why These Nuclei?**

Modern nuclear physics recognizes a sequence of magic numbers

2; 8; 20 ;28 ;50 ;82;126,

corresponding to completely filled nuclear shells.

Whenever either the proton number or neutron number equals one of these values, nuclear stability increases significantly. Nuclei possessing both proton and neutron magic numbers are referred to as double-magic nuclei, representing some of the most stable and structurally ordered nuclear systems known.

The present work proposes introducing a structural parameter, denoted by

$$\Psi$$

which characterizes the sensitivity of the collective nuclear structure to localized perturbations.

Conceptually,

- Small values of ($\Psi$) indicate that removal of an individual nucleon produces only minor structural modifications.
- Large values of ($\Psi$) indicate that removal of a particular nucleon produces substantial collective reorganization of the nucleus.

Consequently, the fundamental scientific question becomes:

***Does there exist a nucleus in which a single nucleon contributes disproportionately to the collective structural stability of the entire nuclear system?***

This question constitutes a legitimate and testable problem in theoretical nuclear physics.

## Group II: Maximum Binding-Energy Nuclei

A second category consists of nuclei possessing the largest known binding energy per nucleon, namely

- Iron-56 ($Fe^{56}$)
- Nickel-62 ($Ni^{62}$)

These nuclei occupy the maximum of the nuclear binding-energy curve and therefore represent some of the most energetically stable nuclei known.

However, high binding energy alone does not necessarily imply the existence of a structurally dominant nucleon.

On the contrary, the strong collective binding characteristic of these nuclei may make them less sensitive to the removal of a single nucleon, since collective interactions are capable of redistributing the resulting perturbation throughout the nuclear system.

Accordingly, although these nuclei provide important reference systems for comparison, they may not represent the most favorable candidates for identifying a Critical Nucleon.

The hypothetical implosive scenario originally motivating this research should therefore be regarded solely as a conceptual thought experiment rather than a prediction derived from established nuclear theory. Its purpose is to illustrate the possible consequences of a hypothetical collective structural instability if such an instability were eventually demonstrated through theoretical or computational investigation.

## Group III: Cluster Nuclei

A third category comprises cluster nuclei, including

- Carbon-12 ($C^{12}$)
- Oxygen-16 ($O^{16}$)

These nuclei are frequently described using alpha-cluster models, in which the nuclear structure is interpreted as a collection of strongly correlated alpha-particle clusters.

Because of their intrinsic cluster organization, their response to structural perturbations may differ significantly from that of conventional shell-model nuclei, making them valuable candidates for comparative investigation.

## Group IV: Weakly Bound (Halo) Nuclei

The final category includes halo nuclei, such as

- Lithium-11 ($Li^{11}$)
- Beryllium-11 ($Be^{11}$)

These nuclei exhibit weakly bound outer neutrons and unusually extended matter distributions.

Although their structures are comparatively fragile, they do not satisfy the principal objective of the present study, namely the investigation of highly cohesive nuclear systems. Nevertheless, they provide useful comparison cases for understanding how structural stability influences collective nuclear behavior.

**From a Critical Nucleon to a Critical Structural Threshold**

The central scientific question of this research is therefore not: "How many nucleons must be removed?", but rather: "Does there exist a critical structural threshold beyond which the collective response of the nucleus changes qualitatively?"

This alternative formulation provides a more flexible and physically plausible research framework.

Under this hypothesis,

- Below the threshold, the nucleus undergoes ordinary structural relaxation and reorganization;
- Above the threshold, the nucleus may enter a

fundamentally different regime characterized by collective structural transition or large-scale nuclear reconfiguration.

Unlike the assumption that a single nucleon alone governs nuclear stability, the concept of a Critical Structural Threshold is more consistent with modern many-body nuclear physics and avoids direct conflict with current theoretical understanding.

Accordingly, the central hypothesis of this study may be summarized as follows:

Certain atomic nuclei may possess a critical structural threshold such that perturbations exceeding this threshold induce a collective structural transition qualitatively different from conventional nuclear responses. The objective of this work is to identify this threshold, if it exists, through theoretical modeling, numerical simulations, and comparison with experimental nuclear-structure data.

## How Can a Neutron Be Removed from an Atomic Nucleus?

### Scientific Feasibility and Theoretical Motivation

One of the principal challenges addressed by the present study is determining whether a structurally critical nucleon can, in principle, be selectively removed from an atomic nucleus.

From the standpoint of contemporary nuclear physics, this is an extremely difficult problem. A neutron is not a localized object that can simply be extracted from the nucleus in the same manner that a mechanical component is removed from a solid structure. Instead, protons and neutrons form a strongly correlated quantum many-body system bound by the strong nuclear interaction.

When an atomic nucleus interacts with energetic particles or high-energy photons, the resulting processes are generally governed by well-established nuclear reaction mechanisms rather than by the selective removal of a particular nucleon. These processes include nuclear excitation, neutron emission, proton emission, heavy-ion fragmentation, induced fission in heavy nuclei, and numerous reaction channels determined by the incident energy and the structure of the target nucleus.

Accordingly, the objective of this work is not to propose a presently available technique capable of extracting a predetermined neutron, but rather to formulate a theoretical research program investigating whether a Critical Nucleon can be identified mathematically and whether future experimental methods might eventually allow its selective perturbation.

### Nuclear Reactions Capable of Removing Neutrons

Although a specific neutron cannot currently be targeted individually, nuclear physics already provides several reaction mechanisms capable of removing neutrons from atomic nuclei.

These reactions are generally referred to as nucleon-transfer reactions, pickup reactions, knockout reactions, or photodisintegration processes, depending on the underlying interaction mechanism.

Rather than employing a mechanical extraction process, neutron removal is accomplished through high-energy nuclear projectiles passing sufficiently close to the target nucleus for the strong nuclear force to induce nucleon transfer.

Two principal reaction mechanisms are particularly relevant.

**Pickup Reactions**

In a Pickup Reaction, a rapidly moving projectile captures a neutron from the target nucleus while continuing along its trajectory.

Typical projectiles include

- high-energy protons (p).
- helium-3 nuclei (He3).
- and other light ions possessing favorable neutron-transfer characteristics.

For example, when a fast proton captures a neutron from the target nucleus, it is transformed into a deuteron,

$$^{1}\mathrm{H} + \mathrm{n} \rightarrow {}^{2}\mathrm{H}$$

and the corresponding nuclear reaction is conventionally denoted by

$$(A)(p,d)(B)$$

The projectile therefore removes a neutron from the target nucleus without complete nuclear fusion.

It should be emphasized that this mechanism differs fundamentally from the Stripping Reaction.

**Stripping Reactions**

In contrast, a Stripping Reaction transfers a nucleon from the projectile to the target nucleus, rather than removing one from it.

Accordingly,

- Pickup Reaction → removes a neutron from the target nucleus.
- Stripping Reaction → adds a nucleon to the target nucleus.
- This distinction is well established in nuclear reaction theory and is essential for correctly interpreting transfer-reaction experiments.

**Knockout Reactions**

Another important mechanism is the Knockout Reaction, in which an energetic projectile collides directly with the target nucleus and ejects a nucleon through a high-momentum transfer process.

Unlike pickup reactions, knockout reactions resemble direct collisions and are widely employed in modern radioactive-beam facilities to investigate nuclear shell structure and nucleon occupancy.

**Can Lasers Remove Neutrons?**

Conventional lasers cannot directly remove neutrons from atomic nuclei because their photon energies are several orders of magnitude below typical nuclear binding energies.

Their interaction is therefore limited primarily to the electronic structure of atoms, producing ionization rather than nuclear reactions.

Ultra-intense laser systems, however, are capable of accelerating electrons, protons, and ions to relativistic energies.

These laser-generated particle beams may subsequently induce neutron-removal reactions through secondary nuclear interactions, including photodisintegration and high-energy nuclear collisions.

Consequently, the laser itself does not extract neutrons directly; instead, it functions as a source of energetic particles capable of initiating nuclear reactions.

**Other Established Neutron-Removal Mechanisms**

Several additional reaction mechanisms are routinely employed in experimental nuclear physics.

- ***Photodisintegration***

High-energy gamma rays may be absorbed by an atomic nucleus, providing sufficient energy for neutron emission.

This reaction is conventionally represented by

$$(\gamma, n)$$

Photodisintegration constitutes one of the standard experimental techniques for investigating neutron binding energies and nuclear excitation spectra.

- ***Nuclear Spallation***

In spallation reactions, the target nucleus is bombarded by extremely energetic protons, typically with kinetic energies of the order of gigaelectronvolts (GeV).

The violent collision fragments the nucleus and produces a large number of secondary neutrons together with numerous nuclear fragments.

Spallation sources are among the most powerful neutron-producing facilities currently available.

**Energy Requirements of Neutron-Removal Facilities:**

The experimental facilities capable of producing high-energy nuclear reactions require extremely large electrical power.

Large particle accelerators and modern spallation neutron sources consume electrical power on the scale of tens of megawatts (MW) rather than kilowatts.

For perspective,

- **1 MW = 1,000 kW.**

The total electrical consumption of a major spallation facility is comparable to that of a large industrial complex and is sufficient to supply electricity to a small town or an entire residential district, corresponding approximately to 30,000–50,000 households, depending on regional patterns of electricity consumption.

These substantial energy requirements illustrate the considerable technological challenges associated with experimentally investigating neutron-removal processes at the frontiers of contemporary nuclear physics.

## Fundamental Principles of the Proposed Framework

The theoretical framework developed in this study is constructed upon a set of fundamental postulates intended to provide a consistent mathematical basis for the proposed Critical Nucleon Hypothesis. These postulates should be regarded as working assumptions forming the foundation of the model rather than established physical laws.

The purpose of introducing these axioms is to formulate a self-consistent theoretical structure from which quantitative predictions may be derived and subsequently evaluated through theoretical calculations, numerical simulations, and experimental investigation.

### Axiom 1: Quantum Equilibrium State

**Postulate**

Every atomic nucleus possesses a unique quantum equilibrium configuration corresponding to the minimum attainable total energy compatible with its nucleon composition.

This equilibrium state is denoted by

$$S_0$$

The state ($S_0$) represents the reference configuration of the nucleus before the application of any external perturbation.

Within the proposed framework, all collective nuclear properties—including binding energy, shell occupancy, nuclear deformation, excitation spectrum, and structural stability—are assumed to be defined relative to this equilibrium configuration.

Accordingly, the nucleus is considered to remain in state ($S_0$) unless an external interaction supplies sufficient perturbation to drive the system toward another quantum configuration.

The present study therefore adopts ($S_0$) as the fundamental reference state from which subsequent structural transitions and critical perturbations are mathematically described.

### Axiom 2: Structural Weight of the Nucleons

**Postulate**

The nucleons constituting an atomic nucleus do not necessarily contribute equally to the collective structural stability of the nuclear system.

Instead, each nucleon is assigned a positive Structural Weight, denoted by

$$w_i$$

such that

$$w_i > 0$$

The Structural Weight of the (i)-th nucleon is defined as the relative reduction in the structural stability of the nucleus resulting from the removal of that nucleon, after allowing the nucleus to relax into a new equilibrium configuration.

Mathematically,

$$w_i = \Delta s_i / s_0$$

where

- ($S_0$) denotes the structural stability of the nucleus before nucleon removal;
- ($\Delta S_i$) represents the reduction in structural stability produced by removing the (i)-th nucleon.

**Structural Cohesion Function**

To provide a more rigorous characterization of the Structural Weight, this study introduces the Structural Cohesion Function, denoted by

$$C$$

which represents the collective structural cohesion of the nucleus in its equilibrium state.

Let

$$C_i$$

denote the structural cohesion of the nucleus after the removal of the (i)-th nucleon and subsequent relaxation into its new equilibrium configuration.

The Structural Weight may then be expressed as

$$w_i = C - C_i$$

Under this formulation,

- (C) represents the structural cohesion of the intact nucleus;
- ($C_i$) represents the structural cohesion after removal of the (i)-th nucleon.

Consequently, the Structural Weight (wi) measures the loss of collective cohesion attributable to the removal of a specific nucleon.

This definition provides an objective mathematical criterion for quantifying the structural contribution of each nucleon to the collective stability of the nucleus and establishes the foundation for identifying the Critical Nucleon introduced in the present study.

## Axiom 3: Structural Distribution Principle

**Postulate**

The collective stability of an atomic nucleus is determined not solely by the total nuclear binding energy, but also by the manner in which structural contributions are distributed among its constituent nucleons.

Accordingly, the structural stability of the nucleus is assumed to be a function of the structural weights of all nucleons,

$$S=f(w_1,w_2,\ldots,w_A)$$

where

- (A) denotes the total number of nucleons contained within the nucleus;
- ($w_i$) represents the structural weight of the (i)-th nucleon as defined in Axiom 2.

This postulate emphasizes that two nuclei possessing comparable total binding energies may nevertheless exhibit different collective responses if their structural weights are distributed differently.

**Definition 1: Structural Cohesion Function**

To quantify the collective structural integrity of the nucleus, we introduce the Structural Cohesion Function, denoted by

$$\Phi$$

and defined as

$$\Phi \sum_{i-1}^{A} w_i$$

The quantity (Φ) is not an energy.

Rather, it is proposed as a new structural index that characterizes the overall cohesion of the nuclear many-body system.

Larger values of (Φ) correspond to greater collective structural cohesion, whereas smaller values indicate a weaker or more fragile nuclear configuration.

Suppose that the (k)-th nucleon is removed from the nucleus.

Following structural relaxation to a new equilibrium state, the Structural Cohesion Function becomes

$$\Phi \sum_{i\neq k} w_i$$

The corresponding structural change is therefore

$$\Delta\Phi = \Phi - \Phi' = wk.$$

Hence, the structural importance of a nucleon is defined as the reduction in collective cohesion resulting from its removal.

This definition provides a direct quantitative measure of the structural contribution of every nucleon to the integrity of the nuclear system.

## Theorem 1

**Uniform Structural Weights Exclude the Existence of a Critical Nucleon**

***Statement***

If all nucleons possess identical structural weights,

$$w1 = w2 = .. = wA = c,$$

where (c) is a positive constant, then the removal of any nucleon produces the same structural effect.

Consequently, no unique Critical Nucleon exists.

***Proof***

Assume

$$w1 = w2 = \cdots = wA = c,$$

From Definition 2,

$$\Delta\Phi = wk.$$

Since every structural weight is identical,

$$wk = c$$

for every nucleon (k).

Therefore,

$$\Delta\Phi = c,$$

independently of which nucleon is removed.

Hence, every nucleon contributes equally to the collective structural cohesion of the nucleus, and no nucleon can be distinguished as structurally more influential than the others.

This contradicts the Critical Nucleon Hypothesis, which requires the existence of at least one nucleon whose structural contribution exceeds that of the remaining nucleons.

Therefore, under the assumption of uniform structural weights, a Critical Nucleon cannot exist.

## Theorem 2: Existence of a Critical Nucleon

***Statement***

Suppose there exists a nucleon (k) whose structural weight exceeds that of every other nucleon in the nucleus, namely,

$$wk > wi, \forall i \neq k.$$

Then the nucleon (k) is identified as the Critical Nucleon.

**Proof**

From Definition 2, the structural perturbation produced by removing the (k)-th nucleon is

$$\Delta\Phi = wk.$$

Since

$$wk > wi, \forall i \neq k.$$

it follows immediately that

$$\Delta\Phi > \Delta\Phi i,$$

for every other nucleon (i).

Therefore, removal of nucleon (k) produces the largest possible reduction in the Structural Cohesion Function, corresponding to the maximum collective structural perturbation of the nucleus.

Hence, according to the definitions established in the present framework, nucleon (k) is uniquely identified as the Critical Nucleon.

**Physical Definition of the Structural Weight**

The preceding mathematical formulation introduces the Structural Weight (wi) as an abstract quantity. To transform the proposed framework into a physically testable model, (wi) must be related to measurable or computable nuclear observables.

Accordingly, this study proposes expressing the Structural Weight of the (i)-th nucleon as a weighted combination of three independent physical contributions,

$$wi = \alpha Si + \beta Oi + \gamma Ci,$$

where

- (Si) denotes the contribution of the (i)-th nucleon to the nucleon separation energy, representing the energy required to remove that nucleon from the nucleus;
- (Oi) denotes the shell occupancy factor, describing the

occupation state of the corresponding nuclear shell within the shell-model framework;

- (Ci) denotes the contribution of the (i)-th nucleon to collective nuclear correlations, including pairing interactions, configuration mixing, and other many-body collective effects.

The coefficients

$$\alpha , \beta , \gamma$$

are dimensionless weighting parameters that determine the relative importance of each physical contribution.

Their numerical values are not assumed a priori but are intended to be determined through calibration against experimental nuclear data, theoretical many-body calculations, or numerical optimization within the proposed model.

This formulation establishes a direct connection between the theoretical concept of Structural Weight and experimentally accessible nuclear quantities, thereby providing a framework through which the Critical Nucleon Hypothesis may be quantitatively evaluated using contemporary nuclear-structure models and available experimental databases.

## Quantitative Mathematical Framework and Neutron Separation Energy [4].

**The Nuclear Backbone Concept**

To investigate the proposed concept of a Critical Nucleon whose removal may initiate a collective structural transition within the nucleus, the present work adopts the quantum-mechanical framework of the Nuclear Shell Model. The standard shell-model Hamiltonian is conceptually extended by introducing a hypothetical structural potential intended to represent the proposed Nuclear Backbone Configuration.

This additional term is introduced solely as a theoretical construct and does not constitute part of the currently accepted nuclear interaction. Its purpose is to provide a mathematical framework within which the proposed hypothesis can be formulated and quantitatively investigated.

**Neutron Separation Energy**

One of the principal physical quantities associated with neutron removal is the neutron separation energy, denoted by

$$S_n,$$

which represents the minimum energy required to remove a neutron from a nucleus containing atomic number (Z) and mass number (A).

It is defined by

$$S_n = [M(Z, A-1) + m_n - M(Z, A]c^2$$

where

- (M(Z,A)) is the nuclear mass of the original nucleus;
- (M(Z,A-1)) is the nuclear mass after removal of one neutron;
- (mn) is the neutron mass;
- (c) is the speed of light in vacuum.

The neutron separation energy is one of the standard observables used in nuclear-structure physics to quantify the binding of individual neutrons within atomic nuclei.

**Conventional Interpretation**

Within conventional nuclear theory, removal of a neutron generally produces a residual nucleus that is less tightly bound than the original system.

The subsequent nuclear evolution is governed by well-established quantum many-body interactions, including shell structure, pairing correlations, collective excitations, and residual nuclear forces.

No accepted theoretical model currently predicts that neutron removal alone results in a spontaneous collapse of the entire nuclear structure.

**Proposed Structural Transition Hypothesis**

The present work investigates an alternative theoretical possibility.

It is hypothesized that, under specific structural conditions, the removed neutron may correspond to a Critical Nucleon occupying a quantum state whose contribution to the collective structural organization of the nucleus is substantially greater than that of neighboring nucleons.

If such a nucleon exists, its removal may not simply reduce the binding energy of the residual nucleus. Instead, it may trigger a collective structural transition involving large-scale reorganization of the nuclear many-body wave function.

Within the proposed framework, this transition is hypothesized to produce a sudden redistribution of nuclear energy levels and a reconfiguration of the collective quantum state of the residual nucleus.

The present study does not assume that such a transition necessarily occurs in nature. Rather, it introduces this possibility as a theoretical hypothesis whose validity must ultimately be examined through rigorous mathematical analysis, numerical simulations, and comparison with experimental nuclear-structure data.

Should such collective structural transitions exist, they would represent a previously unrecognized mode of nuclear behavior extending beyond the conventional description provided by current shell-model theory.

Accordingly, the Nuclear Backbone Configuration introduced in this work should be regarded as a proposed theoretical extension intended to identify whether particular nucleons contribute disproportionately to the collective structural stability of atomic nuclei.

**Modification of the Nuclear Hamiltonian for the Proposed Structural Collapse**

Within the conventional Nuclear Shell Model, the dynamics of nucleons are governed by a Hamiltonian consisting of the kinetic-energy operator together with an effective nuclear potential, commonly represented by the Woods–Saxon potential supplemented by the spin–orbit interaction.

The present work proposes a theoretical extension of this framework by hypothesizing that the removal of a Critical Nucleon may induce a qualitative modification of the effective nuclear potential governing the remaining nucleons.

Accordingly, the Hamiltonian is written as

$$H = -\frac{h^2}{2m}\nabla^2 + V_{collapse}(r)$$

where

- (m) denotes the nucleon mass;
- (h) is the reduced Planck constant;
- $V_{collapse}$ *(r)* is a proposed effective collapse potential introduced within the present theoretical framework.

Unlike the conventional Woods–Saxon potential, the proposed collapse potential is hypothesized to become increasingly attractive in the vicinity of the nuclear center,

$$V_{collapse}(r) \to -\infty, \quad r \to 0.$$

Under this hypothesis, the effective potential well becomes both extremely deep and highly localized following the removal of the Critical Nucleon.

Consequently, the many-body wave function describing the remaining protons and neutrons is hypothesized to undergo a pronounced inward localization, resulting in a highly concentrated quantum state near the nuclear center.

Within the framework of the present study, this hypothetical process is referred to as Atomic Atrophy or Collective Nuclear Structural Collapse.

It should be emphasized that the proposed collapse potential does not belong to the standard Hamiltonian of contemporary nuclear physics. Rather, it is introduced as a phenomenological theoretical extension whose physical validity must ultimately be established through rigorous mathematical analysis, numerical simulations, and experimental verification.

The purpose of introducing ($V_{collapse}$ *(r)*) is therefore not to replace the conventional nuclear potential, but to provide a mathematical representation of the hypothesized structural transition proposed in the Critical Nucleon Hypothesis.

**Quantum Fluid Dynamics and Self-Cavitation [5].**

Within the conventional Liquid Drop Model, the atomic nucleus is treated as an incompressible nuclear fluid whose collective properties successfully describe numerous macroscopic features of nuclear structure.

In the present work, this description is extended by proposing that, under sufficiently strong structural perturbations, the nucleus may be modeled as a highly compressible quantum superfluid capable of undergoing a transient self-cavitation process following the removal of a Critical Nucleon.

This hypothesis is introduced as a phenomenological extension intended to explore possible collective structural transitions beyond the conventional liquid-drop approximation.

**Quantum Continuity Equation**

The time evolution of the nuclear density,

ρn ( r , t ),

is assumed to satisfy a continuity equation analogous to that employed in quantum hydrodynamics and derived from the Gross–Pitaevskii equation,

$$\frac{\partial \text{pn}}{\partial \text{t}} + \nabla .(\rho_n v) = 0$$

where

- (r,t)) is the nuclear density distribution;
- (v) denotes the collective velocity field of the nuclear fluid.

This equation expresses conservation of nuclear matter during the proposed collective structural evolution.

**Self-Cavitation and Nuclear Collapse Equation**

The present hypothesis further assumes that removal of a Critical Nucleon may generate a localized quantum cavity within the geometrical center of the nuclear structure.

If such a cavity forms, the effective nuclear radius,

R ( t ),

is hypothesized to evolve according to a phenomenological equation inspired by the classical Rayleigh–Plesset equation, modified to represent collective nuclear dynamics,

$$R\frac{\text{d}^2\text{R}}{dt^2} = +\frac{3}{2}(\frac{\text{dR}}{\text{dt}})^2 = \frac{1}{\tilde{\text{n}}_{\text{nuclear}}}(\text{P}_{\text{internal}} - P_{vacuum} - \frac{2_\gamma}{\text{R}} - E_{\text{strong]}}).$$

where

- ($\rho_{\text{nuclear}}$) denotes the nuclear matter density;
- ($P_{internal}$) represents the effective internal pressure of the nuclear system;
- ($P_{vaccum}$) represents the effective internal pressure of the nuclear denotes an effective external pressure term introduced within the proposed model;
- (γ) is the effective nuclear surface-tension coefficient;
- ($E_{strong}$) represents the inward effective pressure associated with the proposed collective reorganization of the strong nuclear interaction following removal of the Critical Nucleon.

Unlike the classical Rayleigh–Plesset equation, the above expression is not intended as a direct description of nuclear dynamics. Rather, it serves as a phenomenological mathematical model designed to investigate whether cavity-like collective structural instabilities could arise within the framework of the proposed Critical Nucleon Hypothesis.

Within this theoretical framework, if the effective pressure balance becomes dominated by inward-directed forces throughout the nuclear volume, the nucleus is hypothesized to undergo a collective structural implosion, resulting in a highly localized quantum configuration referred to in this work as Atomic Atrophy.

It should be emphasized that this proposed self-cavitation model constitutes a theoretical extension beyond currently established nuclear physics and is presented solely as a mathematical framework for future analytical, computational, and experimental investigation.

**Modified Gravity and the Emergence of an Extreme Attractive Interaction**

Within the framework of established physics, gravity is extraordinarily weak at nuclear length scales, typically on the order of femtometers ($10^{-15}$m) and nanometers ($10^{-9}$m), Consequently, gravitational interactions are generally negligible in comparison with the strong nuclear force governing nuclear structure.

To investigate the proposed Atomic Atrophy Hypothesis, the present study considers a speculative theoretical extension in which the effective nuclear interaction undergoes a qualitative transition during a critical structural collapse. In this phenomenological framework, the collective reorganization of the nuclear system is assumed to induce an effective enhancement of gravitational coupling at ultra-high nuclear densities.

This concept is inspired by non-standard coupling theories and density-dependent gravitational models, but it does not form part of currently established General Relativity or the Standard Model of particle physics.

**Modified Einstein Field Equations**

To represent this hypothetical behavior mathematically, the Einstein field equations are generalized by replacing the Newtonian gravitational constant with an effective, density-dependent gravitational coupling,

$$\text{G}_{\text{i v}} = \frac{8\pi G_{eff}(\rho)}{c^4} T_{\mu\nu}$$

where

($G_{\mu\nu}$) is the Einstein curvature tensor;

($T_{\mu\nu}$) is the stress-energy tensor;

($c$) is the speed of light in vacuum;

($G_{eff}(\rho)$) is a proposed effective gravitational constant whose value depends upon the local nuclear energy density.

Unlike Newton's gravitational constant ($G$), the quantity ($G_{eff}(\rho)$) is not assumed to be universal. Instead, it is hypothesized to increase dramatically when the nuclear density exceeds a critical threshold during the proposed structural collapse.

The effective gravitational coupling is modeled by the phenomenological relation

$$G_{eff}(\rho) = G_0 exp\left(\frac{\rho}{\rho_{critical}}\right)$$

where

- ($G_0$) denotes the conventional Newtonian gravitational constant;
- ($\rho$) is the local nuclear energy density;
- ($\rho_{critical}$) is a proposed critical density beyond which the effective gravitational interaction becomes significantly enhanced.

**Phenomenological Motivation**

At present, no first-principles derivation exists for the functional form of

$$G_{eff}(\rho)$$

Accordingly, the exponential expression introduced above should be regarded as a phenomenological ansatz, selected because it reproduces the qualitative behavior required by the proposed theoretical model.

Specifically,

- when

$$\rho \ll \rho_{critical},$$

the exponential factor approaches unity,

$$G_{eff} \approx G_0,$$

and the model reduces to conventional gravitational physics.

- As the density approaches the critical value,

$$\rho \rightarrow \rho_{critical},$$

the effective gravitational coupling begins to increase rapidly.

- For densities exceeding the proposed critical threshold,

$$\rho > \rho_{critical},$$

the model predicts that the effective gravitational interaction becomes sufficiently strong to influence the collective dynamics of the collapsing nuclear system.

**Hypothesized Consequences**

Within the proposed framework, this density-dependent enhancement of the effective gravitational coupling may generate an extremely localized attractive region during the collective structural collapse of the nucleus.

The resulting phenomenon is hypothesized to resemble a micro-scale gravitational focusing effect, arising from the concentration of mass-energy into an extremely small spatial region.

The expression "Micro Black Hole Effect" is employed in this work solely as a qualitative analogy describing the predicted localization of the attractive interaction. It does not imply the actual formation of a microscopic black hole as defined by General Relativity.

The validity of this modified-gravity model remains entirely hypothetical and must ultimately be assessed through rigorous theoretical development, numerical simulations, and experimental investigation.

**Structural Phase Transition.**

The present study hypothesizes that the removal of the Critical Nucleon does not merely alter the nuclear binding energy. Rather, it may drive the nucleus into a fundamentally different structural configuration characterized by a distinct degree of internal organization.

This hypothetical transformation is referred to as a Structural Phase Transition.

To describe this transition quantitatively, we introduce a dimensionless Structural Phase Parameter, denoted by

$$X,$$

such that

$$X = 0$$

corresponds to the normal equilibrium nuclear configuration, while

$$X = 1$$

represents the proposed collapsed structural state.

Within this framework, ($X$) serves as an order parameter describing the progression of the nucleus between its equilibrium configuration and the hypothesized collapsed configuration.

**Structural Free Energy**

To characterize the thermodynamic state of the nuclear system, we introduce the Structural Free Energy, denoted by

$$F_s,$$

defined as

$$Fs = U - TS + \lambda\Phi,$$

where

- ($U$) is the internal energy of the nucleus;
- ($T$) is the absolute temperature;
- ($S$) is the thermodynamic entropy;
- ($\Phi$) is the Structural Cohesion Function introduced previously;
- ($\lambda$) is a coupling coefficient describing the interaction between structural cohesion and the thermodynamic energy of the nuclear system.

Unlike the conventional Helmholtz free energy, the proposed quantity ($Fs$) incorporates an additional structural contribution through the cohesion function ($\Phi$), thereby providing a phenomenological measure of the coupling between nuclear structure and thermodynamic stability.

**Differential Form of the Structural Free Energy**

If the nuclear structure undergoes a structural transition, the differential variation of the Structural Free Energy is given by

$$\mathbf{dFs = dU - TdS - SdT + \lambda d\Phi.}$$

For an isothermal process,

$$dT = 0,$$

the above expression reduces to

$$\mathbf{dFs = dU - TdS + \lambda d\Phi.}$$

This relation indicates that variations in the proposed Structural Cohesion Function contribute directly to changes in the Structural Free Energy.

Within the framework of the present hypothesis, the term

$$\lambda\, d\Phi$$

represents the energetic contribution associated with collective structural reorganization during the proposed

Structural Phase Transition.

It should be emphasized that the Structural Free Energy introduced here is a phenomenological thermodynamic quantity proposed specifically for the present theoretical framework. It is not part of the standard formalism of equilibrium nuclear thermodynamics, but rather a mathematical construct intended to describe the coupling between collective nuclear structure and the hypothesized structural transition associated with the Critical Nucleon Hypothesis.

**Thermodynamics and Endothermic Energy Absorption (Exceptional Cooling)**

For the proposed structural collapse to be accompanied by exceptional cooling rather than conventional thermal explosion, it is hypothesized that the kinetic and thermal energy of the nuclear system is collectively converted into gravitational and quantum potential energy through a strongly endothermic structural transition.

Within this framework, the collapse is assumed to act as an ideal energy sink, in which thermal energy is absorbed by the structural reorganization of the nuclear system instead of being released as heat.

***Modified Energy Conservation and Thermal Energy Deficit***

The entropy of the collapsing nuclear system is hypothesized to decrease sharply as the system evolves toward a highly ordered collective quantum configuration.

Within the phenomenological framework proposed in this study, the corresponding heat exchange follows the thermodynamic relation

$$\delta Q = T\, dS\ ,$$

or, for finite changes,

$$\Delta Q = T\Delta S.$$

It is further hypothesized that the structural collapse drives the remaining nucleons toward a highly coherent collective quantum state, qualitatively analogous to a pressure-induced Bose-Einstein-like condensation.

Consequently, the structural disorder of the system is assumed to decrease dramatically,

$$\Delta S \rightarrow -\infty,$$

reflecting the proposed transition toward a highly ordered nuclear configuration.

**Structural–Entropy Coupling**

The present model assumes that the entropy variation is directly proportional to the magnitude of the structural collapse.

Accordingly,

$$\Delta S = -\eta\, \Delta\Phi,$$

where

- ($\Delta\Phi$) denotes the variation of the Structural Cohesion Function;
- ($\eta > 0$) is a newly introduced phenomenological coupling coefficient relating structural reorganization to entropy variation.

Substituting this relation into the thermodynamic equation yields

$$Q$$

$$Q = -T\eta\, \Delta\Phi.$$

This expression predicts that a reduction in structural cohesion is accompanied by negative heat exchange, corresponding to an endothermic process within the proposed theoretical framework.

***Exceptional Cooling Mechanism***

According to the proposed hypothesis, the mathematical decrease in entropy implies that the collapsing nuclear system absorbs thermal energy from its surroundings in order to complete the structural phase transition.

As a consequence, the surrounding medium is predicted to undergo a sudden and pronounced decrease in temperature.

Within the conceptual framework of the present study, this phenomenon is interpreted as the thermodynamic counterpart — or inverse analogue — of conventional nuclear fission, where energy is released explosively. Here, the proposed structural collapse instead results in an exceptionally strong endothermic response accompanied by rapid cooling.

It should be emphasized that this mechanism is introduced as a phenomenological theoretical hypothesis and is not derived from the standard formulation of equilibrium thermodynamics or contemporary nuclear physics.

***Summary of the Proposed Mathematical Framework***

The theoretical framework developed in this study may be summarized by the following sequence of coupled physical processes:

$$\text{Critical Nucleon} \rightarrow \Delta\Phi \rightarrow Fs \rightarrow \Delta S \rightarrow Q$$

where

- removal of the Critical Nucleon initiates a structural perturbation;
- the perturbation modifies the Structural Cohesion Function ($\Phi$);
- the resulting structural change alters the Structural Free Energy (Fs);
- the free-energy variation induces a corresponding entropy change ($\Delta S$);
- and the entropy variation determines the associated heat exchange (Q).

**Integrated Mathematical Model**

The complete theoretical model proposed in this work may be expressed as the following sequence of interconnected processes:

***Trigger:***

The removal of the structurally critical neutron, characterized by the neutron separation energy (Sn), modifies the effective nuclear potential (V(r)) appearing in the Schrödinger equation.

**Structural Dynamics:**

The modified nuclear Rayleigh–Plesset equation governs the inward evolution of the proposed quantum nuclear fluid, driving the nuclear radius toward a collapsed configuration,

$$R \rightarrow 0.$$

**Gravitational Response:**

When the nuclear density exceeds the proposed critical threshold, the density-dependent effective gravitational coupling,

$$G_{eff}\,(\rho),$$

is activated within the phenomenological model, producing the hypothesized localized attractive field.

**Thermodynamic Response:**

The sharp reduction in entropy associated with the structural transition,

$$\Delta S < 0,$$

drives endothermic heat absorption from the surrounding environment, thereby giving rise to the proposed Exceptional Cooling mechanism.

Together, these coupled processes constitute the mathematical foundation of the Critical Nucleon Hypothesis and define the proposed theoretical pathway from nucleon removal to collective structural transition, localized attractive interaction, and exceptional thermodynamic response.

**Precise Theoretical Assumptions Extending Beyond Classical Physics.**

The proposed framework intentionally introduces several theoretical assumptions that extend beyond the domain of currently established classical and quantum physics. These assumptions are not presented as established physical laws, but rather as phenomenological extensions introduced to formulate a mathematically self-consistent model capable of describing the proposed Critical Nucleon Hypothesis.

Accordingly, the present work assumes that, under sufficiently extreme structural conditions, the domain of validity of certain conventional physical laws may require extension or modification.

**Density-Dependent Gravitational Coupling**

Within Newtonian gravity, the universal gravitational constant,

$$G,$$

is a fundamental constant whose value is assumed to be invariant throughout nature,

$$G = 6.67430 \times 10-11\ m^3\ kg^{-1}\ s^{-2},$$

and the gravitational interaction depends exclusively on the masses of the interacting bodies and the distance separating them.

In the present hypothesis, however, the effective gravitational interaction is assumed to depend not only on mass but also on the local nuclear density.

Specifically, the Newtonian gravitational constant is replaced by a density-dependent effective coupling,

$$G^{eff}(\rho),$$

whose magnitude is hypothesized to increase exponentially once the nuclear density exceeds a critical threshold during the proposed structural collapse.

The exponential functional form is adopted as a phenomenological ansatz because it satisfies several desirable mathematical properties:

- continuity;
- differentiability;
- recovery of the conventional Newtonian constant at ordinary densities;
- rapid growth beyond the proposed critical density.

Within the present framework, the effective gravitational constant is therefore assumed to become a function of the local nuclear density after the critical structural threshold is exceeded.

This behavior is not proposed as an experimentally established law of nature. Rather, it is introduced as a mathematical extension within the proposed theoretical model, in which collective structural reorganization of the nucleus becomes coupled to the critical density, allowing its influence to dominate over the comparatively small reduction in mass resulting from nucleon removal.

**Departure from the Classical Mass–Gravity Proportionality**

According to Newtonian gravity, removing a neutron from an atomic nucleus necessarily decreases its total mass.

Consequently, the gravitational attraction generated by the nucleus must also decrease.

Within the proposed framework, however, a different hypothesis is considered.

Although the removal of a neutron reduces the total mass of the system, the effective attractive interaction is hypothesized to increase dramatically owing to the extreme concentration of mass-energy associated with the proposed structural collapse.

Accordingly, the model assumes that the effects of ultra-high density and structural compression outweigh the comparatively small decrease in total mass.

This assumption intentionally departs from the classical Newtonian description and represents one of the principal theoretical extensions introduced in the present work.

**Modification of Gravitational Behavior at Microscopic Length Scales**

Within Newtonian gravity and conventional classical physics, gravitational interactions are negligible at atomic and nuclear length scales.

Indeed, gravity is approximately

$$10^{36}$$

times weaker than the strong nuclear interaction responsible for binding nucleons inside atomic nuclei, rendering its influence effectively insignificant in comparison with the nuclear and electromagnetic forces [1].

The present hypothesis assumes a fundamentally different behavior.

Specifically, it proposes that once the nucleus undergoes the hypothesized structural collapse and exceeds a critical structural threshold, an effective attractive interaction emerges that dominates the collective dynamics of the nuclear system.

Accordingly, the model postulates the appearance of a new effective gravitational regime operating only under these extreme structural conditions.

This effective interaction is assumed to become the dominant attractive mechanism within the proposed mathematical framework while remaining distinct from conventional Newtonian gravity.

**Modified Gravity Within the Proposed Framework**

The theoretical framework developed in this study therefore does not employ classical Newtonian gravity to describe the proposed structural-collapse regime.

Instead, it adopts a phenomenological Modified Gravity approach, in which the mathematical form of the gravitational interaction is assumed to change under conditions of extreme density and microscopic length scales [6].

Within this framework, the conventional Newtonian formulation is regarded as valid under ordinary physical conditions but potentially insufficient once the proposed critical structural density has been exceeded.

Accordingly, the present work introduces a mathematical extension intended to operate only within this hypothesized regime, without asserting that it replaces the established laws governing gravitational interactions under normal conditions (Figure1).

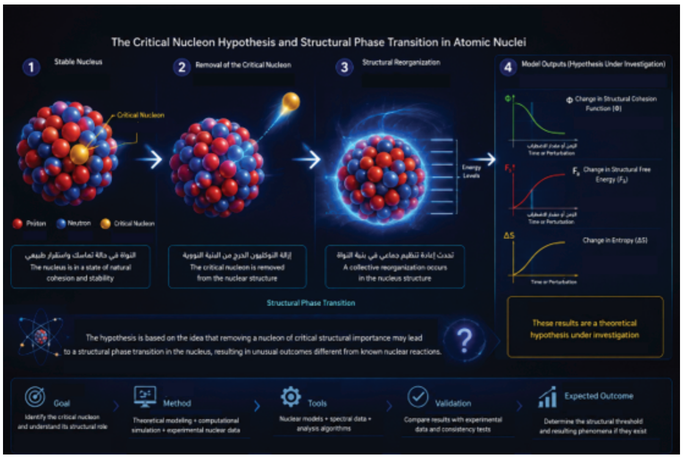


***Figure 1.*** *Conceptual representation of the Critical Nucleon Hypothesis, illustrating the proposed extraction of a structurally critical neutron from a highly cohesive atomic nucleus, triggering a hypothetical structural phase transition that produces an intense localized attractive (suction-like) field.*

## Testable Scientific Predictions of the Proposed Model

If the proposed hypothesis is valid, the theoretical framework developed in this study leads to several experimentally and computationally testable predictions.

### Prediction I: Existence of a Critical Structural Threshold

The model predicts that the nucleus does not undergo structural collapse in a gradual or continuous manner. Instead, a Critical Threshold is assumed to exist.

Specifically,

$$\rho < \rho c,$$

corresponds to the conventional nuclear regime, in which no anomalous structural behavior is expected.

However, once the nuclear density reaches or exceeds the proposed critical value,

$$\rho \geq \rho c,$$

the model predicts the occurrence of a sudden structural transition.

From a practical standpoint, this implies that numerical simulations involving the sequential removal of nucleons would exhibit only minor structural variations until a specific critical nucleon (or structural threshold) is reached, at which point a qualitative transition in the nuclear configuration would occur.

This constitutes a clear and testable prediction of the proposed model.

### Prediction II: Not All Neutrons Contribute Equally to Nuclear Stability

Conventional nuclear physics generally characterizes neutrons according to quantities such as their separation energies and quantum shell configurations.

The present model proposes an additional structural concept: the Critical Nucleon.

According to this hypothesis, the decisive factor is not merely the number of neutrons within the nucleus, but rather the structural significance of a particular nucleon.

Consequently, the model predicts that the removal of two neutrons possessing similar separation energies may nevertheless produce substantially different structural responses if one neutron corresponds to the proposed Critical Nucleon, whereas the other represents an ordinary nucleon.

If verified, this would constitute a qualitatively new prediction extending beyond the conventional interpretation based solely on binding energy.

### Prediction III: Structural Phase Transition Within the Atomic Nucleus

The proposed framework further predicts the existence of a Structural Phase Transition occurring inside the atomic nucleus.

Conceptually, this transition is analogous to familiar phase transitions observed in condensed matter systems, such as the transformation of liquid water into ice.

Rather than evolving continuously, the system is hypothesized to undergo an abrupt transition upon reaching a critical structural condition.

Accordingly, the proposed evolution may be represented schematically as

$$\text{Stable Phase} \rightarrow \text{Critical Point} \rightarrow \text{Structural Phase}$$

Within this framework, the nucleus is therefore hypothesized to possess a critical structural point at which it transitions from its ordinary equilibrium configuration to a distinct collective structural state.

The existence of such a nuclear structural phase transition represents one of the principal theoretical predictions of the Critical Nucleon Hypothesis and provides a potential avenue for future theoretical investigations, numerical simulations, and experimental verification.

### Prediction IV: Breakdown of Conventional Nuclear Models

If the proposed hypothesis is valid, the model predicts that certain existing nuclear models will fail to accurately describe the behavior of nuclei undergoing the proposed structural transition.

Specifically, conventional frameworks such as the Nuclear Shell Model and the Liquid Drop Model are expected to lose predictive validity once the proposed Critical Nucleon has been removed, as these models do not explicitly incorporate the structural cohesion mechanism hypothesized in the present work.

### Prediction V: Emergence of a New Structural Parameter

The present framework introduces the Structural Cohesion Function, denoted by

$$\Phi,$$

as a new phenomenological quantity characterizing the collective structural integrity of the nucleus.

If the hypothesis is correct, conventional binding energies alone will no longer provide a complete description of nuclear stability.

Instead, nuclear systems would require characterization by both their energetic properties and their structural cohesion.

Accordingly, the proposed model predicts that nuclear stability is governed not only by binding energy, but also by the newly introduced Structural Cohesion Function.

## Prediction VI: Existence of Highly Sensitive Nuclear Isotopes

The proposed framework further predicts that isotopes possessing nearly identical masses may nevertheless exhibit fundamentally different structural behavior.

According to conventional nuclear models, isotopes with similar masses are generally expected to display comparable structural properties.

In contrast, the present hypothesis proposes that one isotope may lie close to the proposed Critical Structural Threshold, whereas another isotope with nearly identical mass may remain far from it.

Consequently, one nucleus may undergo the predicted structural transition while the other remains in its ordinary equilibrium state.

This prediction provides another experimentally testable consequence of the proposed theoretical framework.

## Prediction VII: Nonlinear Structural Response

Within conventional nuclear physics, small variations in physical parameters generally produce correspondingly small changes in the behavior of the nuclear system.

The present model proposes a fundamentally different response.

Specifically, it predicts that gradual increases in the structural perturbation may initially produce little or no observable effect,

Such behavior is characteristic of a nonlinear response, in which a small incremental change beyond a critical threshold produces a disproportionately large structural transformation.

## Prediction VIII: Existence of a Critical Structural Cohesion Value

The proposed model predicts the existence of a critical value of the Structural Cohesion Function,

$$\Phi c,$$

which governs the structural state of the nucleus.

Specifically,

$$\Phi > \Phi c,$$

corresponds to a stable nuclear configuration.

When

$$\Phi = \Phi c,$$

the nucleus reaches the proposed critical point at which collective structural reorganization begins.

Finally, if

$$\Phi < \Phi c,$$

the nucleus is hypothesized to enter the proposed new structural phase.

Within the present theoretical framework, the Structural Cohesion Function,

$$\Phi,$$

therefore plays the role of an order parameter, analogous to those employed in the theory of phase transitions, providing a quantitative measure of the structural state of the nuclear system.

## Prediction IX: Divergence from Conventional Numerical Simulations

The proposed framework predicts that numerical simulations performed using conventional approaches, such as Molecular Dynamics (MD) or Nuclear Mean-Field Models, may produce results that differ systematically from those obtained using the present theoretical model.

Specifically, under identical initial conditions, conventional models are expected to generate one class of structural evolution (Curve A), whereas the proposed framework predicts an alternative evolution (Curve B), owing to the inclusion of the Critical Nucleon concept and the Structural Cohesion Function.

Importantly, this prediction remains testable through comparative numerical simulations even in the absence of direct experimental observations.

## Prediction X: Emergence of a New Structural Regime

Rather than predicting a simple increase in gravitational strength, the proposed framework predicts the emergence of a qualitatively distinct Dominant Structural Regime.

Within this regime, the collective behavior of the nuclear system is hypothesized to be governed by the proposed effective gravitational coupling,

$$G_{eff}$$

instead of the conventional Newtonian gravitational constant,

$$G.$$

Accordingly, the transition is interpreted not merely as an amplification of gravity, but as the onset of a new structural regime characterized by density-dependent effective interactions operating exclusively under the extreme conditions assumed in the present model.

## Prediction XI: Structural Importance Ranking of Nucleons

If the proposed hypothesis is valid, every atomic nucleus is expected to contain one—or a limited subset of—nucleons whose contribution to the collective structural stability of the nucleus is significantly greater than that of the remaining nucleons.

Consequently, the model predicts the existence of a Structural Importance Ranking, in which nucleons are ordered according to their structural significance rather than their spatial position, shell occupancy, or individual quantum numbers.

Within this framework, the proposed Critical Nucleon corresponds to the nucleon occupying the highest position in this structural hierarchy, representing the dominant contributor to the collective stability of the nuclear configuration.

The existence of such a structural ranking constitutes one of the central predictions of the Critical Nucleon Hypothesis and provides a clear objective for future theoretical calculations, numerical simulations, and experimental investigation.

## Safety Considerations and Containment Framework

If the proposed mechanism were capable of generating an extreme localized attractive interaction accompanied by exceptional cooling, conventional laboratory materials would be inadequate for safely containing such a process. Accordingly, the present work proposes a conceptual safety framework based on advanced physical principles. These concepts are entirely hypothetical and are presented solely within the context of the proposed theoretical model.

### Quantum Magnetic Isolation Shields (Quantum Meissner Shields)

A superconducting magnetic field is proposed to surround the reaction chamber.

Within the framework of the present hypothesis, this field is not intended primarily for thermal insulation but rather to confine the proposed localized structural collapse and limit the propagation of the hypothesized attractive field to the immediate vicinity of the reaction center.

This concept represents a speculative extension inspired by quantum magnetic shielding and is introduced solely as a theoretical containment mechanism.

### Neutron Feedback Grid

The reaction chamber is hypothesized to be surrounded by a neutron-delivery system capable of rapidly injecting compensating neutrons immediately following the desired structural transition.

Within femtoseconds after the proposed attractive event has been achieved, the system would deliver a controlled pulse of free neutrons intended to restore the structural balance of the collapsed nucleus and terminate the transition before any hypothetical cascading process could develop.

### Controlled Trigger Pulse and Range Calibration

The proposed Neutron Stripper Beam should be precisely programmed to regulate both the number of removed nucleons and the duration of the excitation pulse.

Accurate control of these parameters is assumed to be essential for maintaining the structural transition within the desired operational regime while preventing uncontrolled evolution of the proposed process.

### Automatic Structural Recovery (Auto-Decay)

Within the proposed model, the collapsed ultra-dense state is hypothesized to possess a strong tendency to recover structural equilibrium.

Following completion of the intended structural transition, the system is assumed to gradually absorb surrounding thermal neutrons or undergo internal nuclear rearrangements that restore the nucleus toward a stable configuration.

This hypothetical self-recovery mechanism is introduced as a phenomenological stabilization process within the proposed framework.

### Emergency Neutralization System (The Neutralizer)

As an emergency shutdown mechanism, the present framework proposes a conceptual Hyper-Neutron Flood, in which a dense pulse of compensating neutrons is injected into the collapsed nuclear region.

Within the hypothesis, these additional neutrons are assumed to restore the structural configuration of the nucleus, terminate the proposed attractive interaction, eliminate the associated cooling process, and stabilize the system at its newly established equilibrium state.

## Potential Applications and Future Perspectives

At the present stage, it is premature to propose practical applications for the theoretical framework developed in this study.

Any technological implementation depends entirely upon future theoretical validation, numerical simulations, and experimental confirmation of the proposed hypothesis.

Nevertheless, if the underlying principles were eventually verified, the proposed framework could motivate future investigations into several potential applications.

From a conceptual perspective, these may include large-scale geophysical engineering, controlled modification of geological structures, and advanced space technologies.

Possible long-term applications might involve controlled terrain modification, localized restructuring of massive geological formations, and novel approaches for manipulating large celestial bodies.

One speculative example concerns planetary defense.

If a large asteroid were approaching Earth, the proposed concept suggests the following hypothetical sequence:

- **A** directed beam would target the interior of the asteroid in an attempt to induce the proposed structural transition.
- **B** The asteroid would hypothetically undergo rapid structural contraction accompanied by a significant reduction in its internal thermal energy.
- **C** According to the proposed model, the resulting compact object could become a highly dense and structurally stable body whose trajectory might be more readily controlled than that of the original asteroid.

These possibilities remain entirely speculative and are presented solely to illustrate potential implications should the proposed theoretical framework eventually prove valid.

Looking further ahead, one may envision future technologies based on this concept taking the form of directed-wave systems capable of inducing localized structural transitions remotely, or alternatively embedded structural devices designed to initiate controlled internal transformations within a target material.

At the present time, however, these concepts should be regarded exclusively as theoretical thought experiments rather than practical engineering proposals.

## Conclusion

The theoretical framework presented in this study extends substantially beyond established nuclear physics and is founded upon several interconnected hypotheses, including the proposed concepts of Atomic Atrophy, Critical Nucleons, Modified Gravity, and Exceptional Endothermic Cooling.

Taken together, these assumptions define a speculative phenomenological model intended to stimulate theoretical discussion rather than provide an experimentally established description of nuclear matter.

The central idea of a silent structural implosion, producing localized attractive interactions and endothermic effects instead of conventional explosive energy release, represents an attempt to explore a possible inverse symmetry of familiar nuclear processes.

Historically, many major advances in physics have originated from bold theoretical hypotheses that initially extended beyond accepted paradigms before becoming the subject of rigorous mathematical analysis and experimental testing.

In the same spirit, the present work should be viewed as a proposal for a new theoretical framework whose scientific value ultimately depends upon its ability to generate quantitative predictions, withstand mathematical scrutiny, and be subjected to experimental verification.

Whether the proposed hypothesis ultimately proves correct or incorrect, the formulation of new theoretical ideas remains an essential driving force in the advancement of physics and the continued development of human scientific knowledge.

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