

Galaxy Evolution Based on a Revised Nuclear Model: A Unified Explanation for Quasars and Superheavy Nucleosynthesis

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Abstract

• **Background:** Mainstream astrophysics, based on traditional nuclear and nuclear force models, posits that during the late evolution of massive stars, their iron cores undergo gravitational collapse due to insufficient energy release from fusion, triggering supernova explosions and forming neutron stars or black holes. This framework struggles to explain quasars' immense and sustained energy output, multiple spectral redshifts, and fails to effectively guide stable superheavy element synthesis.

• **Problem:** This paper challenges conventional understanding of nuclear forces and iron core behavior, identifying an overlooked slow fusion pathway in stellar iron cores during late evolution stages.

• **Core Argument:** Based on a revised nuclear structure model (where nucleons exist as "subprotons" and "subneutrons" in dynamic transformation; see preprint viXra:2412.0014 submitted on 2024-12-05), we propose that extreme gravitational pressure in ultra-massive stars drives preferential fusion of iron cores into hyperons (e.g., Σ , Ξ). These hyperons rapidly decay as intermediate products, generating high-energy γ photons and free neutrons.

• **Results:** This process initiates cascade reactions: 1) γ photons activate outer iron cores via photoneuclear reactions, synthesizing superheavy elements (atomic numbers 104–118) through neutron/proton capture; 2) forms a layered core structure (iron crystal lattice, superheavy nucleus layer, neutron layer); 3) fast neutrons from the core bombard superheavy nuclei, releasing enormous energy that melts through the iron shell. Under strong magnetic fields and rotational forces, polar jets form, ultimately dispersing the stellar envelope and evolving into observed quasars.

• **Conclusion:** This framework naturally explains quasar energy mechanisms (non-gravitational collapse energy), primary redshift sources (close-range strong gravitational redshift), and multiple redshift phenomena. It predicts a novel, high-yield pathway for stable superheavy nucleosynthesis under high-pressure environments with γ photon and neutron fluxes. This study calls for fundamental reconsideration of nuclear physics foundations and stellar evolution models.

1. Introduction

1.1 Since their discovery, quasars' characteristics—high luminosity, compact size, significant redshifts, and superluminal jets—have continuously challenged traditional astrophysical models. Although mainstream theories attribute them to active galactic nuclei (AGN) **【1】**, critical details about their energy mechanisms and observational features (e.g., multiple redshifts, association with ordinary galaxies) remain highly controversial.

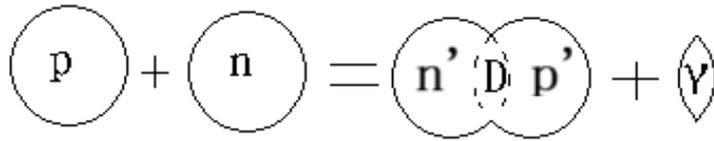
1.2 Current theoretical difficulties originate from singular (cognition) of stellar endpoints—the "iron core death-collapse-supernova paradigm" **【2】**, built upon traditional nucleon and nuclear force models.

1.3 Based on a revised nuclear structure theory, this paper demonstrates that traditional models overestimate the energy threshold for iron core collapse into pure neutron stars. We propose a more energetically favorable fusion channel from iron cores to hyperons within ultra-massive stars.

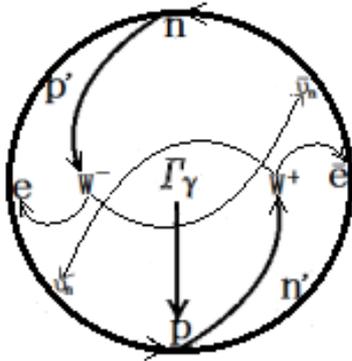
1.4 This work aims to elaborate this novel evolutionary sequence of ultra-massive stars, proving its capacity to unify explanations for quasars, pulsar supernovae, neutron stars, and other astrophysical observations, while providing revolutionary directions for superheavy nucleosynthesis.

2. Revised Nuclear Model and Hyperon Fusion Channel

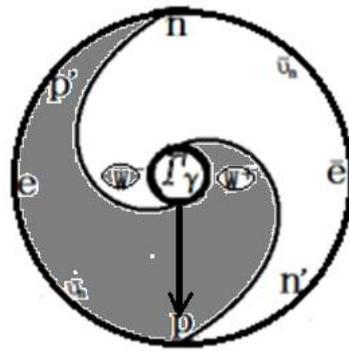
2.1 Brief Description of Nucleon Revision Model: Atomic nuclei contain no independent protons/neutrons retaining original mass but consist of mass-deficient "subprotons" and "subneutrons" forming dynamic interconversion systems. Iron cores (^{56}Fe), with highest average binding energy, represent the most stable configuration of this structure.



Schematic Diagram of Mass Defect in the Synthesis of Deuteron from Proton and Neutron



Scientific Model Diagram of Deuterium Dynamic Variations



Dynamic Evolution of the Taiji Yin-Yang Diagram in Deuterium Nuclei

2.2 Hyperons as Preferred Intermediates: Under extreme pressures in ultra-massive star cores, electron energies become insufficient to directly convert "subnucleons" into free neutrons. Instead, adjacent nucleon pairs preferentially coalesce into hyperons (e.g., Σ^0 , Ξ). Calculations show five nucleons fusing into four hyperons (or three into two) matches mass ranges of Σ/Ξ hyperons ($\Lambda^0 \approx 1115.4$ MeV, $\Xi \approx 1314$ MeV; $\Sigma^0 \approx 1192.3$ MeV) **【3】**. With iron's average binding energy at 8.55315 MeV and nucleon masses (neutron: 939.56563 MeV, proton: 938 MeV including screening electrons), the approximate mass conservation holds:

$$(939.037815 - 8.55315) \times 5 \div 4 \approx 1163 \text{ MeV}$$

$$(939.037815 - 8.55315) \times 3 \div 2 \approx 1395 \text{ MeV}$$

These values align with hyperon mass ranges (1115.4–1321 MeV), most likely corresponding to Σ^0 .

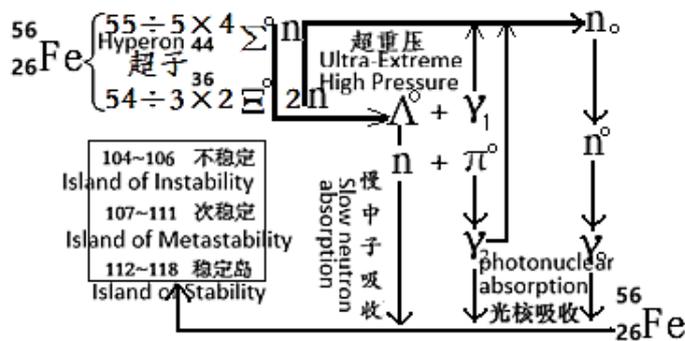


Diagram of the supernova evolution process

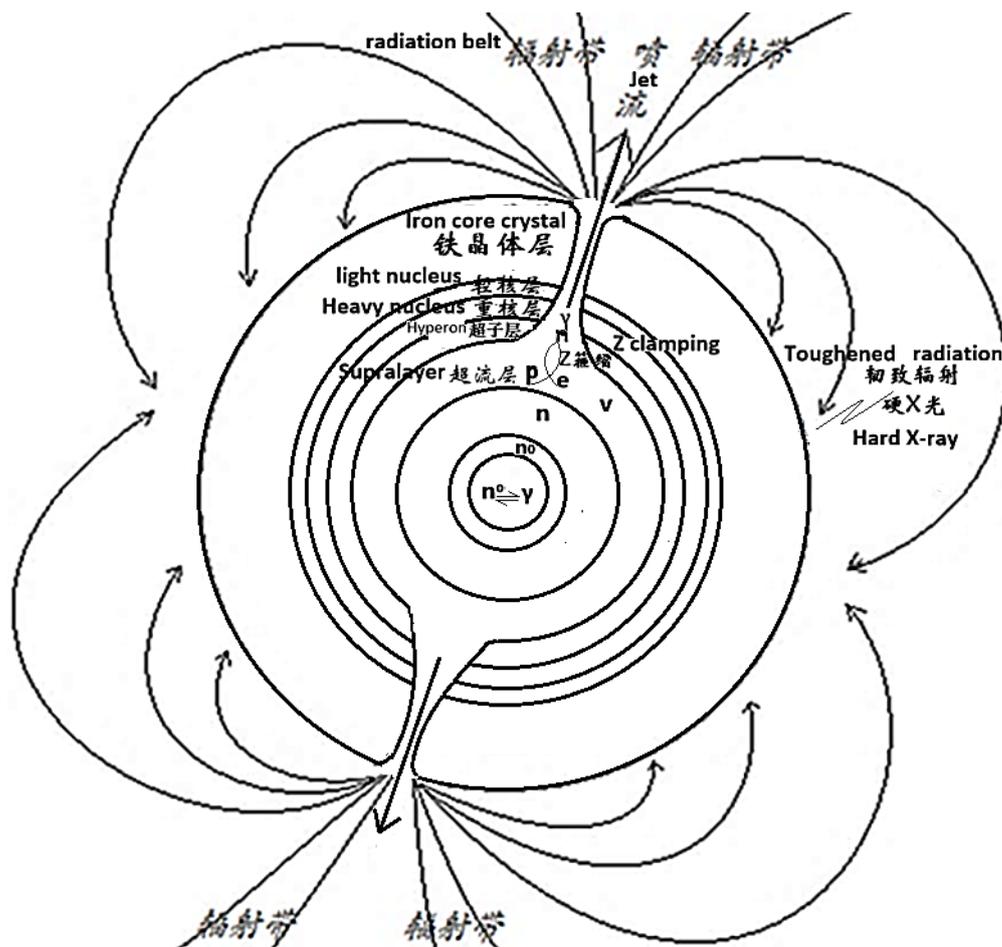
2.3 Cascade Decay and Energy/Particle Emission: Primary hyperons (e.g., Σ^0) rapidly decay ($\sim 10^{-10}$ s) into Λ^0 and γ photons, followed by Λ^0 decay into neutrons (n) and π^0 mesons, with π^0 ultimately decaying into γ photons. This generates two key products driving subsequent evolution: ultra-high-energy γ photon fluxes and high-intensity free neutrons.

3. Ultra-Massive Star Core Evolution and Structural Stratification

3.1 Photonuclear Reactions and Superheavy Nucleosynthesis: High-energy γ photons produced in the core strike outer iron nuclei, The photonuclear reactions induce an excited state in the nuclei and reduce their average binding energy. These "activated" iron nuclei undergo "adhesive" fusion through absorption of secondary gamma photons, slow neutrons, protons, and alpha particles (with the superfluid layer formed by proton Z-pinch cascade fusion), thereby gradually synthesizing elements with higher atomic numbers.

3.2 Formation of Layered Structure: Due to the decreasing energy of gamma photons and neutrons during outward radiation, the atomic numbers of synthesized elements exhibit a gradient distribution decreasing from the interior outward: * Innermost layer: Superheavy elements (SHE) numbered 118–104 synthesized from multiple iron nuclei. * Intermediate layer: Elements numbered 103–56 synthesized from three or two iron nuclei. * Outer shell: Unreacted iron nucleus crystals

3.3 Formation of Neutron Star Nucleolus and Magnetars: Under immense pressure, the core region forms a neutron star nucleolus composed of different dense neutron states (n , n_0 , n_0 decaying into intense gamma radiation). The entire system (neutron nucleolus + superheavy nucleus layer + ferromagnetic crystalline shell) becomes a rapidly rotating strong magnet—a magnetar. Neutron decay (p , e) on the nucleolus surface and resynthesis under the Z-pinch mechanism maintain an approximate dynamic equilibrium (since magnetic energy continuously generates neutrinos: $e + p \rightarrow n + \nu$, while antineutrinos from neutron decay annihilate into escaping gamma photons).



Quasir-stellar Object Structural Diagram

(Note: The hyperon layer exists during initial nuclear photoabsorption and neutron capture in stellar cores but disappears in bare-core quasars. Retained here to illustrate its significance as an intermediate evolutionary stage)

4. Quasar Formation and Observational Characteristics Explanation

4.1 Evolutionary Sequence from Hypernovae to Quasars: Hypernova → Hydrogen-rich Wolf-Rayet star (WRxh, strong stellar wind) → Pulsating supernova (e.g., iPTF14hls, polar intermittent jets) → Quasar. For example, R136a1 in the R136 superstar cluster of the Spider Nebula is a young blue hypergiant that has evolved into a hydrogen-rich Wolf-Rayet star [4].

4.2 Polar Jet Mechanism: Fast neutrons generated by the neutron nucleolus continuously bombard the superheavy nucleus layer, producing enormous energy. Combined with localized heating from Z-pinch effects, this eventually penetrates the anisotropic iron nucleus crystalline shell. Under intense magnetic fields, magnetic wind vortices form at both poles, expelling residual plasma at high speeds and dispersing the stellar envelope, exposing the hot core. This represents a strong quasar emerging through internal breakthrough.

4.3 Energy Generation Efficiency: Powerful polar jets radiate tremendous energy, while synchrotron radiation in radiation belts produces various electromagnetic waves. Additionally, extreme gravitational forces cause most expelled light/heavy nuclei, neutrons, electrons, and protons to be pulled back toward the stellar surface, generating bremsstrahlung and isomer radiation. Consequently, quasars exhibit extremely slow mass loss but produce enormous energy. Even outer plasma layers, due to complex turbulence, generate plasma excitons radiating significant energy and neutrino-antineutrino pairs, ultimately manifesting as gamma-ray annihilation (at distant locations). Bremsstrahlung and isomer radiation produce intense X-ray emissions. Thus, quasars represent the universe's most efficient energy generators! They embody the perfect combination of electromagnetic force (manifested as Lorentz force) and gravitational force.

4.4 Unified Explanation of Quasar Mysteries:

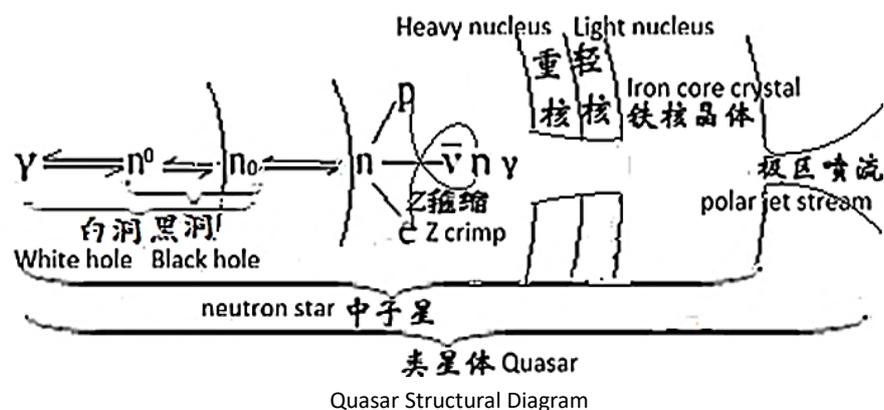
* **Energy Source Mystery:** Primarily originates from fast neutron fission of superheavy nuclei, gamma rays from annihilation, synchrotron radiation of protons/electrons in polar jets and radiation belts (causing superluminal motion and blueshift phenomena), plus bremsstrahlung and isomer radiation from heavy nucleus fallback.

* **Redshift Mystery:** Mainly caused by strong gravitational redshift at the stellar surface rather than cosmological distance. * **Multiple Redshifts:** Differing redshift magnitudes result from varying gravitational potentials between emission lines (near the surface, large redshift) and absorption lines (from distant environments, smaller redshift).

* **Partial Blueshift:** Caused by synchrotron radiation from relativistic particles in magnetic layers.

4.5 Quasars, Neutron Stars, and Black Holes

However, stellar nuclear fusion forming iron cores doesn't require hypernovae—it occurs in stars exceeding ~10 solar masses (M_{\odot}). Before core collapse triggers supernova explosions, these iron cores initiate the aforementioned fusion processes. Under various influences, fast neutrons generated via Z-pinch mechanisms can create superheavy nuclei but may fail to melt through iron nucleus crystalline layers to form polar jets, resulting in "neutron stars" (weak neutron stars). The mechanism is illustrated below:



From this diagram, the difference between fully structured neutron stars and quasars lies solely in the absence of

polar penetration jets. Thus, under certain conditions (e.g., high outer-layer temperatures melting part of the iron nucleus into liquid, thinning the inner iron nucleus layer for easier penetration and increased temperature facilitating melting), such neutron stars can easily break through the iron nucleus crystalline barrier to become new "quasars" (external breakthrough transforming weak neutron stars into weak quasars). Naturally, neutron stars might lack iron nucleus crystalline layers or even superheavy nucleus layers. Pure neutron stars without heavy nuclei still possess polar energy jets formed by accelerated protons/electrons from neutron decay under ultrastrong magnetic fields. Beyond this lie black holes and white holes! White holes differ from black holes by emitting continuous intense gamma-ray radiation, whereas black holes emit minimal energy radiation.

4.6 Special Dwarf Stars and Quasars: Of course, if the neutron layers in quasars undergo continuous decay and generate fast neutrons through Z-pinch mechanisms to bombard outer layers, gradually depleting their internal matter reserves, they will eventually decay into special dwarf stars—extremely evolved remnants of quasars. Due to their unique characteristics, these objects are often misidentified as ordinary red dwarfs. For instance, Barnard's Star, traditionally classified as a dim M4-type red dwarf and considered one of the oldest stars in the Milky Way (with an age of 7–9 billion years), was observed by astronomers in 1998 to exhibit intense stellar flaring activity [5]. This observation led scientists to propose that Barnard's Star might actually be a young flare star! This apparent contradiction becomes readily understandable when recognizing Barnard's Star as a special remnant quasar that has undergone re-accretion of primitive nebular material.

In fact, such objects are not rare; rather, most undergo absorption and coalescence upon entering new primordial nebulae, eventually undergoing nuclear fusion anew to form seemingly ordinary new dwarf stars (like our Sun). Alternatively, under extreme conditions, these newly formed dwarf stars may have their outer layers stripped away, exposing the residual bare core (similar to our Moon).

5. Deductions and Verification

5.1. Supplement to the Stellar Evolution Diagram: The traditional evolutionary pathway should incorporate routes such as "hypernova → quasar → white hole".

5.2. Implications for Solar System Formation: A speculative model is proposed: Earth's core might be an "exogenous" decaying quasar (containing a neutron kernel), while the Moon could represent the remnants of two severely decayed quasars (hollow shells) – where a smaller one collided with the incoming Earth core, fragmenting upon impact to form the present lunar body. This collision scattered high-gravity mass concentrations across the Moon's surface, followed by the Earth core assimilating both lunar fragments to form the new Earth. This model provides novel explanations for the Earth-Moon relationship (Earth as daughter, Moon as mother) and anomalous phenomena in the Earth-Moon system, including two large shear-wave low-velocity zones in the deep mantle, the Moon's starkly contrasting nearside/farside topography, and its helium-3 enrichment puzzle.

5.3. Experimental Verification and Superheavy Nucleus Synthesis Prediction: The most direct validation of this theory involves modifying existing heavy-ion collision protocols [6]. By simulating high-pressure environments with intense γ -photon fluxes, neutron flows, and α -particle admixtures within a Z-pinch device, iron cores could undergo fusion reactions aiming to directly synthesize stable superheavy elements (SHE) between atomic numbers 104–118. Successful synthesis would strongly support the nuclear model and astrophysical framework presented herein.

6. Conclusion

This paper establishes a unified evolutionary framework for hypernovae based on revised nuclear physics foundations. The model interprets quasars as bare-core phases in hypernova evolution, deriving their energy and observational characteristics from core processes including strange matter fusion, superheavy nucleus synthesis/fission, and radiation mechanisms in strong magnetic/gravitational fields. This framework resolves

multiple fundamental enigmas of quasars and proposes revolutionary, experimentally testable directions for superheavy element synthesis, urging interdisciplinary reevaluation at the intersection of fundamental physics and astrophysics.

References:

- 1、 Peterson B. M., *An Introduction to Active Galactic Nuclei*, Cambridge Univ. Press (1997); Rees M. J., *Nature* 211, 468 (1966); Kellermann K. I. et al., *ApJ* **659**, 1 (2007)
- 2、 Peterson B. M., *An Introduction to Active Galactic Nuclei*, Cambridge Univ. Press (1997); Rees M. J., *Nature* 211, 468 (1966)
- 3、 Peterson B. M., *An Introduction to Active Galactic Nuclei*, Cambridge Univ. Press (1997); Rees M. J., *Nature* 211, 468 (1966)
- 4、 Crowther P. A. et al., *MNRAS* 408, 731 (2010)
- 5、 Kürster M. et al., *A&A* 334, L17 (1998)
- 6、 Adamczyk L. et al., *Phys. Rev. Lett.* 119, 062301 (2017)