The Helium Torus: The Source of Cold in a Bounded Water-Matrix Universe

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Abstract:
The cold of the cosmos is assumed to be a relic of fire. The helium that fills the cosmos is assumed to be ashes. This paper joins both assumptions in a single question — and answers it with a machine. In the bounded cosmology established in prior work, the universe is a gravastar interior: a shell at $R = 4.4\times10^{26}$ m, threaded by the neck of the Unified Hourglass gravastar, immersed in the water-matrix lattice. This paper identifies the working substance of that machine: helium. A single gaseous torus of helium on the cold exterior of the shell — one ring, not two; the doubling seen from inside is the projection of the one — feeds inward through the neck's reduction conditions, where the black-hole physics are real, and establishes both the temperature floor of the bounded system and the pressure environment within which all interior matter is buoyant. Six results follow. First, the shell equilibrium computed from stellar luminosity and geometry alone returns 2.72 K against the measured 2.7255 K of the cosmic microwave background — agreement to 0.2 percent. Second, the lambda transition of helium-4 at 2.17 K sets the floor beneath the equilibrium; the measured temperature sits 0.55 K above it, the signature of a regulated bath. Third, the latent heat capacity of the cosmological helium inventory, 7.6×10^{57} J, equals roughly thirty years of the combined output of every star — the cold is not scarce; it is structural. Fourth, the breathing of the shell operates as a thermodynamic cycle in which every stage cools, because the system runs forty kelvin below helium's inversion temperature, and the boundary displacement at which the cycle functions is fixed by the Israel junction conditions — the shell cannot sit elsewhere. Fifth, buoyancy mechanics is developed as the interior force law: displacement replaces attraction, orbits become equilibrium depth layers, and flat rotation curves follow without dark matter, with a falsifiable exponent prediction for void galaxies. Sixth, the abundance ladder of hydrogen, helium, and water is read as the composition of the medium itself. Every calculation can be verified by pencil and paper. The predictions are stated where they can fail in public.

Keywords: Helium, Cold, Bounded Universe, Gravastar, Water-Matrix Lattice, Israel Junction Conditions, Adiabatic Cooling, Torus, Buoyancy, Cosmic Microwave Background, Element Abundance.

1. Introduction

The night sky is dark, and the space between the stars is cold. Prior work established that the darkness is arithmetically consistent with a bounded universe: an absorbing shell surrounding a finite population of stars reaches thermal equilibrium at 2.72 K against the measured 2.7255 K of the cosmic microwave background [1]. That calculation established a number. It did not identify the working substance. A temperature does not maintain itself. Something inside a bounded system must carry heat to the boundary, and something must set the floor beneath which the system cannot fall.

This paper proposes that the something is helium.

The proposal is not arbitrary. Helium is the second most abundant element in the universe, approximately 24 percent of ordinary matter by mass, exceeded only by hydrogen [2]. It is the only element that cannot be solidified at any temperature below a pressure of 2.5 megapascals; it possesses no conventional triple point; and under conditions found throughout interstellar space it remains fluid to absolute zero [3]. It is chemically untouchable: the completeness of its electron shell renders it essentially non-reactive and non-binding with other media, so that it passes through environments that arrest every other substance [4]. It is, in laboratory practice, the working substance of all cryogenics — every temperature below 4 K reached by human technology is reached through helium. In this model, helium flows through the water-matrix lattice — the medium established in prior work as the substrate of the metric [5] — unimpeded by the hydrogen-bond network that binds water to everything else.

Cold, however, is only half of helium's office. The same gas is the pressure environment of the interior: the medium within which matter floats. The thermodynamics is developed in Sections 4 through 6; the buoyancy mechanics in Section 7. One substance, two offices — the floor and the float — delivered in a single paper.

The paper holds to established physics throughout. General Relativity is not discarded but grounded: the strained lattice produces the Schwarzschild line element and recovers the classical tests, and the shell boundary satisfies the Israel junction conditions [1][5][14]. The boundary displacement is not chosen; it is demanded — Section 3 shows that the junction conditions fix the shell at the unique displacement at which the interior pressure balance holds, with observable thermodynamic consequences. The mathematics of string theory is retained where it has demonstrated success — the surface-optimization geometry shown in 2026 to govern the branching of neurons, vasculature, trees, corals, and plants [6] — and interpreted as the geometry of the medium. What is new here is the thermodynamics and the mechanics: helium, outside and inside, as the source of cold and the source of buoyancy.

The structure is as follows. Section 2 catalogs the measured properties of helium. Section 3 locates the helium in the bounded architecture: the single exterior torus, the crossing through the neck, and the locked boundary. Section 4 presents the temperature convergence. Section 5 computes the heat capacity against the stellar load. Section 6 develops the breathing cycle. Section 7 develops buoyancy mechanics as the interior force law. Section 8 examines the composition of the medium. Section 9 states the predictions. Section 10 separates what is measured from what is proposed. Every calculation herein can be verified by pencil and paper.

2. The Measured Properties of Helium

The following are measured facts:

Helium-4 constitutes approximately 24 percent of the mass of ordinary matter in the universe [2]. Hydrogen constitutes approximately 74–75 percent; all other elements together approximately 2 percent.

Helium's atmospheric boiling point is 4.2 K. Below 2.17 K, at saturated vapor pressure, liquid helium undergoes the lambda transition to the superfluid phase, in which heat transport is wave-like rather than diffusive [3]. Helium possesses no conventional triple point: the vapor-pressure line and the melting line never intersect, and helium does not freeze below 2.5 MPa at any temperature, down to absolute zero [3]. Of every element, only helium refuses solidification outright.

The Joule–Thomson inversion temperature of helium is approximately 40–45 K [7]. Above this temperature, expanding helium warms; below it, expanding helium cools. A system at equilibrium near 2.7 K lies some forty kelvin below this threshold. Every expansion of cosmological helium therefore cools, without exception, by the ordinary physics of real gases.

Adiabatic expansion cools monatomic helium unconditionally when the gas does work on its surroundings, $TV^{(\gamma-1)}$ = constant, $\gamma = 5/3$. The latent heat of vaporization at 4.2 K is 20.8 J/g [3]. The enthalpy of helium gas between room temperature and liquid-helium temperature is approximately 1.5 MJ per kg — some seventy times the latent term per kilogram [3]: the gas-phase heat-carrying capacity dominates, and the phase boundary acts as the temperature-pinning mechanism rather than the bulk heat carrier.
These are the measured properties. What follows applies them to the bounded architecture.

3. The Location of the Helium: One Torus, the Crossing, and the Locked Boundary

3.1 One torus

The bounded universe established in prior work consists of a gravastar shell of radius $R = 4.4\times10^{26}$ m enclosing a finite population of stars immersed in the water-matrix lattice [1]. The present model adds to this architecture a single helium torus, and it must be stated at the outset what is singular and what is doubled. There is one torus. It is located on the exterior of the cosmological shell, on the cold side of the bounded system: one ring of cold gaseous helium encircling the matte-face gravastar body, from which the cold of the interior flows. The doubled torus reported from interior vantage points is an appearance, not a structure — the connected projection of the one ring seen along the folded sight-lines of the bounded geometry. The doubled-torus vortex topology described in prior work applies to the field structure of nested compact objects, principally Sagittarius A* [5]; at the cosmological boundary there is one ring, and the double is what we see.
The mass budget is fixed by the baryonic census. Using the critical density $\rho_c \approx 8.6\times10^{-27}$ kg/m³ and $\Omega_b \approx 0.049$: the volume of the sphere is $(4/3)\pi R^3 \approx 3.56\times10^{80}$ m³; the mean baryonic density is $\rho_b \approx 4.2\times10^{-27}$ kg/m³; the total baryonic mass is $M_b \approx 1.5\times10^{54}$ kg (3.1). The helium fraction, 24 percent by mass:

$$M_{He} = 0.24 \times 1.5\times10^{54} \text{ kg} \approx 3.6\times10^{53} \text{ kg} \quad (3.2)$$

comprising approximately 5.4×10^{79} helium-4 atoms.

If dispersed uniformly, the mean helium density is $\rho_{He} \approx 1.0\times10^{-27}$ kg/m³ — approximately 0.15 atoms per cubic meter, the same order as the warm-hot intergalactic medium. The observed census of baryons in the recent universe accounts for less than half the total inferred from the cosmic microwave background — the missing baryon problem [8]. Roughly half the universe's helium is unaccounted for by observation. The exterior torus is a candidate residence for material the standard model has misplaced; Section 9 states how this can be tested.
The mean dispersion establishes a further property relevant to the model: at ~0.15 atoms per cubic meter, the gas is so dilute that it behaves essentially ideally, and its thermal state is governed entirely by the volume and pressure history imposed on it — that is, by the breathing of the sphere.

3.2 The crossing: the neck of the hourglass

The torus does not decorate the shell; it feeds through it. The architecture is the Unified Hourglass gravastar of prior work [5]: two spheres joined through a narrow neck. The helium circulates through the whole circuit — exterior ring, shell crossing, interior lattice, and the reduction conditions of the neck — in a single continuous flow. The crossing is governed by real physics. The shell sits at $R \approx R_s(1 + \varepsilon)$, and the passage through the reduction conditions traverses genuine black-hole physics: the same junction conditions, the same extreme temporal dilation, with observable consequences catalogued in [5]. What crosses the shell is processed by the shell. The black-hole physics stand.

3.3 The locked boundary

The shell displacement is not a free parameter; it is fixed by the Israel junction conditions [14][5]. The ratio of internal proper time to external coordinate time at the shell is governed by the Schwarzschild temporal component, $\Delta t_{int}/\Delta t_{ext} = \sqrt{(1 - R_s/R)}$. The junction conditions require the de Sitter interior pressure ($p = -\varepsilon$) to balance the gravitational pull of the shell at the surface tension the thin-shell formalism assigns; this equilibrium selects the displacement $R = R_s(1 + \varepsilon)$ with $\varepsilon \approx 7.5\times10^{-12}$, at which the square-root factor equals 1/365,250. The shell cannot function elsewhere: a smaller displacement tips the pressure balance outward; a larger one, inward. The ratio follows from arithmetic — square 2.73×10^{-6}, subtract from one — and any reader with the toolkit of Appendix A can verify it. The calculation is not a mathematical trick played on the boundary conditions; it is a requirement of them. The boundary must have this number in order to function.

The thermodynamic consequence is stated without interpretation: thermal energy crossing the shell is redshifted by the factor $\gamma \approx 3.65\times10^{5}$ ($T_{ext} = T_{int}/\gamma$). The interior at 2.7 K presents, to the exterior, an effectively zero-temperature surface. The matte face of the gravastar body is the observational signature of this redshift: the shell does not lack energy; the locked dilation gates its exit. The cold side of the architecture is cold by the same junction conditions that hold the shell up, and the helium floor is cold by thermodynamics — the boundary arithmetic and the phase floor operate together.

The helium that comes through the neck serves two offices: it is the carrier of cold (Sections 4–6), and it is the working substance of buoyancy, whose density against the lattice sets the equilibrium depth at which bodies float (Section 7). One substance, two functions.

4. The Temperature Convergence

Two calculations, performed by different routes, arrive at the same temperature.

Route 1: The shell equilibrium. An absorbing shell surrounding $N = 2\times10^{22}$ stars of average luminosity $L = 3.8\times10^{26}$ W at radius $R = 4.4\times10^{26}$ m reaches equilibrium when absorbed stellar power equals radiated power:

$\sigma T^4 = NL/(4\pi R^2)$ (4.1)

Substituting: $NL = 7.6\times10^{48}$ W; $4\pi R^2 = 2.43\times10^{54}$ m²; $\sigma = 5.67\times10^{-8}$ W m^{-2} K^{-4}. This yields $T^4 = 55.2$, and:

$T_{shell} = 2.72$ K (4.2)

against the measured cosmic microwave background temperature of 2.7255 ±0.0006 K [9] — a difference of 0.2 percent.

Route 2: The helium floor. The coldest naturally maintainable temperature of the bounded system is set by the phase boundary of its most abundant cold-working substance. Helium's lambda transition — beneath which its heat transport becomes wave-like and its fluidity frictionless — occurs at:

$T_\lambda = 2.17$ K (4.3)

The measured temperature sits 0.55 K above this floor.

The convergence. The bounded system's equilibrium temperature, computed from stellar luminosity and shell geometry alone, lands at 2.72 K. The phase floor of its most abundant refrigerant sits at 2.17 K. The measured temperature, 2.7255 K, satisfies both constraints simultaneously: it matches the shell equilibrium to 0.2 percent, and it sits above the helium floor by 0.55 K — the offset expected of a bath in sustained contact with

a heat source settling above its own floor. The helium sets how low the system can go; the stellar load sets where it does settle; the observed value obeys both.
It should be stated plainly that this is a bracketing relationship, not an independent confirmation. Route 1 is arithmetic on three measured inputs; Route 2 is a phase boundary measured in the laboratory. Whether this bracketing reflects physical reality or numerical coincidence can be settled only by the predictions of Section 9.

5. The Heat Capacity of the Inventory

The thermal energy of the full helium inventory at shell temperature, for a monatomic gas ($C_v = (3/2)Nk_B$):
$E_{thermal} = 1.5 \times 5.4\times10^{79} \times 1.38\times10^{-23} \times 2.725 \approx 3.0\times10^{57}$ J (5.1)

The latent heat capacity of the full inventory, cycled once completely through the vapor boundary:
$Q_{latent} = M_{He} \times L_v = 3.6\times10^{53}$ kg $\times\ 2.08\times10^{4}$ J/kg $\approx 7.6\times10^{57}$ J (5.2)

The sensible heat capacity of the gas phase is some seventy times larger per kilogram [3], placing the total thermal working capacity of the inventory on the order of 10^{58}–10^{59} J.

Against this, the total stellar power of the bounded universe is 7.6×10^{48} W. The latent reserve alone, per single complete cycle, equals roughly 10^{9} seconds — approximately thirty years — of the combined output of every star. The arithmetic permits one conclusion: within the bounded model, the helium inventory is a heat sink the stars cannot fill. The equilibrium at 2.7255 K is not maintained despite the stellar load; it is maintained with a reservoir in surplus by orders of magnitude. The cold is not scarce. It is structural.

6. The Breathing Cycle

The bounded sphere breathes: a periodic expansion and contraction of the shell — a heartbeat — with period τ and volumetric stroke ratio V_{max}/V_{min}. The helium inventory, interior and toroidal, is the working gas. The mechanism, stated plainly:

1. Expansion stroke. The sphere expands. The interior helium gas does work on its surroundings and cools adiabatically: $T \propto V^{(-2/3)}$, $\gamma = 5/3$. The torus swells and contracts with the stroke — the breathing of the ring is the heartbeat.
2. Throttling through the neck. Helium circulating through the gravastar interior passes the reduction conditions of the neck — where the extreme strain documented in [5] resides — under a pressure differential. Because the system operates at 2.7 K, some forty kelvin below helium's inversion temperature, this Joule–Thomson throttling cools monotonically [7]. There is no regime of the cycle in which the flow warms.
3. Transport through the lattice. Cold helium moves through the water-matrix lattice unimpeded. This is documented chemistry, not conjecture: helium's closed electron shell renders it the least interactive of all substances — essentially insoluble, non-reactive, minimally polarizable [4]. The gas and the medium are complementary extremes: the molecule that bonds asymmetrically to everything, and the atom that bonds to nothing.
4. Exhaustion at the boundary. Heat carried to the shell is radiated at the equilibrium temperature of Section 4, gated by the locked dilation of Section 3.3. Steady state requires exported power equal absorbed power (Eq. 6.1).
5. Floor pinning. The cycle cannot cool the gas below the saturation curve at local pressure; further heat extraction goes to latent heat, not temperature. The condensation boundary at 2.17 K pins the floor and stabilizes the equilibrium against runaway: the system self-regulates. A colder system would condense its

working gas and lose circulation; a hotter system would drive faster export. The measured 0.55 K offset above the floor is the signature of a regulated bath, not an accident.

$\dot{Q} = (f \cdot M\_He \cdot L\_v) / \tau = 7.6\times10^{48}$ W (6.1)

where f is the fraction of the inventory cycled through the phase boundary per beat. Equation (6.1) fixes the product f/τ: for a stroke cycling one part in 10^9 of the inventory per beat, the required period is on the order of one year; for $f = 10^{-12}$, on the order of minutes. The circulation fraction and the period are not free independently — the equilibrium binds them, and this binding is a testable constraint (Section 9).
The work done per adiabatic stroke, $W = nR(T_1 - T_2)$ for the polytropic path, is carried with every intermediate step in Appendix A.

7. Buoyancy Mechanics: The Interior Force Law
Cold is helium's first office. The second is lift. The same gas that pins the temperature floor of Section 4 and pumps the cycle of Section 6 also supplies the pressure environment of the interior — and in this section, displacement replaces attraction as the interior force law.

The restoring force is displacement. In the standard account, matter orbits because it falls. In the bounded model, matter floats because it displaces. The interior helium, threading the water-matrix lattice, distributes in a density gradient set by the circulation of Section 6: richest where the through-flow is strongest, thinnest in the voids. A body immersed in this gradient experiences a restoring force toward its equilibrium depth — the height at which its displacement against the lattice-helium medium balances — precisely as a hydrometer settles in a stratified column. Density mismatch against the medium, not attraction toward mass, is the restoring force. The equivalence principle survives intact: every body, regardless of composition, seeks the depth where its displacement balances, just as every body falls identically in the gravitational account. The phenomena agree; the mechanism differs.

Orbits are equilibrium depth layers. A stable orbit, in this framework, is a body oscillating gently about its equilibrium depth while its tangential velocity is conserved. The tangential component is untouched by the restoring force — the displacement acts along the gradient only — so a body set moving sideways stays moving sideways, at constant speed, for the same reason a puck glides across frictionless ice. Kepler's orbits become the ballistic trajectories of a floating world: bound motion is not falling around a mass, but coasting within a layer. The observed circularity of planetary and stellar orbits follows from the same damping that settles the hydrometer: dissipation along the gradient is finite, dissipation in the tangential direction is zero, so what remains after settling is circular motion at equilibrium depth.

Flat rotation curves without dark matter. The restoring force is set by the local density of the working medium. Within a galaxy, the interior helium distribution is rich — the galaxy is a deep pool, and the depth gradient is shallow: a body far from the center displaces nearly as much as one near it. If the restoring gradient is flat, the equilibrium is flat, and the tangential velocity required to remain at equilibrium depth is the same at every radius. v(r) = constant is not the signature of unseen mass; it is the signature of a medium whose density profile the luminous matter traces. The rotation-curve flatness that standard cosmology purchases with dark matter, the bounded model obtains from the measured abundance of its working gas. The full derivation, including the Newtonian limit and the void prediction with its exponent, is carried in Appendix A, A.8 through A.11.

The void prediction. Voids are where the working gas thins. A galaxy in a void floats in a lean medium — the depth gradient is steeper, the equilibrium tighter, and the rotation curve falls off faster than the flat profile of gas-rich regions: $v(r) \propto r^{(1/2 - \beta/2)}$ with β measurably greater than the field-galaxy value, per Appendix A.10. This is the model's own signature, separable from the standard account. The prediction is falsifiable against survey rotation-curve data, and it inherits the anisotropy test of Section 9 — the void distribution and the torus geometry are set by the same circulation.

One substance, two offices, one architecture. The helium that enters through the neck of the hourglass carries the cold and constitutes the medium. The floor of Section 4 and the lift of this section are the same gas doing its two jobs. Remove the helium and the bounded universe loses both its thermostat and its mechanics — which is the sense in which the identification is a single proposal, not two.

8. The Composition of the Medium

The abundance ladder. The universe is hydrogen (~74%), helium (~24%), and then everything else (~2%) [2]. Oxygen is the third most abundant element — the bulk ash of stellar fusion. Hydrogen and oxygen combine to form the most stable molecule available to them: water, detectable in every astrophysical environment examined with sufficient sensitivity [1][10]. The universe's two dominant elements, plus the most abundant stable compound of the two, constitute the medium: water as the lattice, helium as the working gas. The three-way ranking is not an accident. It is the bill of materials.

Cold binding. The standard account attributes the hydrogen-helium ratio to hot neutron counting: seven protons to every neutron at freeze-out, every surviving neutron locked into helium-4, the remainder hydrogen [2]. The present framework offers the complementary attribution: cold binding. Particles form as quasi-crystalline vortexial structures in magnetar- and gravastar-class fields [11]; the natural attractors of such a cascade are the simplest stable vortex (the proton) and the most bound light nucleus (helium-4, doubly magic, the tightest binding energy per nucleon of the light elements). A cascade settling toward minimum-energy configurations concentrates mass in free protons and helium-4, with deuterium and lithium-7 as trace residuals — matching the observed ladder. The discriminating arena between hot counting and cold binding is the deuterium and lithium abundances, precisely where the standard model carries its known difficulties — the lithium-7 discrepancy of a factor of two to three [12].

The medium named. Cold Genesis theory models particle formation in a sub-quantum fluid medium via vortex cascades, populated by hypothetical constituents — sinergons, quantons — constructed so that the fluid can carry gravitation and magnetism [11]. No experiment has detected these constituents. In the present framework, the sub-quantum medium is identified as the water-matrix lattice; the auxiliary particle constructs are not adopted, and the theory's fluid mechanics is retained. Cold Genesis theory predicted a particle near 17 MeV/c^2 in 2011; in 2016, Krasznahorkay et al. reported an anomalous neutral boson at 16.70 ±0.35 (stat) ± 0.5 (sys) MeV/c^2 in beryllium-8 nuclear transitions [13], and observations consistent with this mass have since been reported by multiple laboratories. In the present framework the predicted particle is treated as a vibrational mode of the strained lattice [5]. The author of that theory modeled the medium correctly without naming it. Water can do all of it.

The geometry works where the medium is. The mathematics of string theory, applied in 2026 to six classes of biological networks — human neurons, fruit-fly neurons, human vasculature, tropical trees, corals, and Arabidopsis — was found to govern their branching as surface optimization, outperforming a century of wiring-minimization theory and predicting functional orthogonal sprouts, 98 percent of which terminate in synapses [6]. String theory has produced no testable prediction of fundamental physics in four decades; pointed at water-based living systems, its geometry lands immediately on the money. Within the present framework this is a fingerprint: the deep geometry of minimal surfaces describes the lattice, and the lattice is most visible in living water systems. The biologist studying a coral and the cosmologist studying the shell are examining the same substance's organizational rules at different scales.

9. Predictions

The model can fail. The following observations would discriminate it:

1. Helium at the boundary. The exterior torus predicts anisotropic helium signature at the largest scales — a pole-to-pole asymmetry in diffuse helium against the shell geometry. The missing baryon census [8] places roughly half the universe's helium unaccounted for; the torus is a candidate residence. Survey data sufficient to test the anisotropy either exist in current archives or will shortly.
2. Temperature stability bounds. The breathing cycle's period and stroke are bounded by the observed stability of the microwave background temperature — the spectral-distortion limits constrain how fast the bath can fluctuate, hence the product f/τ of Equation (6.1). Any proposed period inconsistent with these limits falsifies the cycle as specified.
3. Void rotation curves. Section 7's prediction — steepened rotation-curve fall-off in void galaxies, where the working gas thins — is a quantitative signature: $v(r) \propto r^{(1/2 - \beta/2)}$ with β measurably greater than the field-galaxy value, per Appendix A.10. Survey rotation-curve compilations that bin galaxies by environment test the exponent directly.
4. The element discriminators. The cold-binding account of the abundance ladder differs from hot neutron counting in its deuterium and lithium predictions. Improved primordial abundance measurements at metal-poor sites test which account survives. The lithium-7 discrepancy is presently unresolved in the standard model [12].
5. The floor relationship. The bracketing of Section 4 is falsifiable in the strict sense: if the measured background temperature were found anywhere that violates either constraint — above the shell equilibrium by more than the stellar budget permits, or below the helium condensation floor at the relevant pressure — the model fails.
6. The locked boundary. The displacement fixed by the junction conditions carries its own observable chain, catalogued in [5] with tests beginning within the current decade. If those tests fail, the locked boundary fails, and the breathing cycle loses its throat.

10. Discussion

What is measured, and what is proposed, is distinguished as honesty requires.

Measured: that helium constitutes approximately 24 percent of baryonic mass; that helium's lambda transition occurs at 2.17 K and its boiling point at 4.2 K; that helium cannot be solidified below 2.5 MPa at any temperature and possesses no triple point; that helium's inversion temperature is 40–45 K, below which expansion cools; that helium's latent heat of vaporization is 20.8 J/g and its sensible enthalpy some seventy times greater per kilogram; that helium is the least interactive of all substances; that the absorbing-shell calculation returns 2.72 K against a measured 2.7255 ±0.0006 K [9]; that surface-optimization geometry governs the branching of six classes of biological networks [6]; that an anomalous neutral boson near 17 MeV/c^2 has been reported in independent laboratories [13], with exclusions noted; that the observed baryon census of the recent universe accounts for less than half the inferred total.

Proposed: that a single helium torus encircles the exterior of the cosmological shell on the cold side, the doubled appearance being an interior projection; that this helium circulates through the neck of the Unified

Hourglass gravastar and constitutes both the carrier of cold and the working substance of buoyancy; that the boundary displacement locked by the Israel junction conditions gates the thermal exit and stands behind the matte face of the shell; that the medium's displacement gradient supplies the interior force law, flat rotation curves reflecting a logarithmic medium profile and void galaxies exhibiting steepened fall-off as $r^{(1/2 - \beta/2)}$ (Appendix A.9, A.10); that the abundance ladder reflects cold binding; that the sub-quantum medium of Cold Genesis theory is the water-matrix lattice; that the surface-optimization geometry describes the lattice.

Agreement is not proof. A model can fit data and still be wrong. The bracketing of Section 4 is a consistency relationship; the heat capacity of Section 5 is arithmetic on measured inputs within a proposed architecture; the breathing cycle of Section 6 contains one bound parameter product, f/τ, which the equilibrium fixes but does not uniquely determine. The buoyancy mechanics of Section 7 is a scaling argument — it demonstrates that flat curves and Keplerian limits are consistent with a logarithmic medium profile, and does not derive that profile from the circulation independently; the exponent test of A.10 is where the claim meets observation. These cautions are stated here so that no reader may mistake them for unstated. What distinguishes this model from unfalsifiable frameworks is that every load-bearing number can be checked by pencil and paper, and every architectural claim is exposed to observation. The predictions are stated where they can fail in public. No conclusions are drawn. The calculations are offered for evaluation.

Appendix A. The Mathematical Toolkit: How to Read Every Number in This Paper

A.1 The shell equilibrium. Multiply star count by luminosity: $2\times10^{22} \times 3.8\times10^{26}$ W = 7.6×10^{48} W. Square the radius and multiply by 4π: $(4.4\times10^{26})^2 \times 12.57 \approx 2.43\times10^{54}$ m². Divide: $7.6\times10^{48} / 2.43\times10^{54} \approx 3.13\times10^{-6}$ W/m². Divide by the Stefan–Boltzmann constant and take the fourth root: $(3.13\times10^{-6} / 5.67\times10^{-8})^{(1/4)} = (55.2)^{(1/4)} \approx 2.72$ K.

A.2 The helium inventory. Cube the radius and multiply by $4\pi/3$: $(4.4\times10^{26})^3 \times 4.19 \approx 3.56\times10^{80}$ m³. Multiply by the critical density and the baryon fraction: $8.6\times10^{-27} \times 0.049 \times 3.56\times10^{80} \approx 1.5\times10^{54}$ kg. Take 24 percent: 3.6×10^{53} kg. Divide by the mass of a helium-4 atom (6.64×10^{-27} kg): approximately 5.4×10^{79} atoms.

A.3 The latent reserve. Multiply the inventory by the specific latent heat: 3.6×10^{53} kg $\times$ 2.08×10^{4} J/kg $\approx$ 7.6×10^{57} J. Divide by the stellar power: $7.6\times10^{57} / 7.6\times10^{48} = 10^9$ seconds. Convert: 10^9 s $\approx$ 31.7 years.

A.4 The thermal energy. Multiply three-halves by the atom count, Boltzmann's constant, and temperature: $1.5 \times 5.4\times10^{79} \times 1.38\times10^{-23} \times 2.725 \approx 3.0\times10^{57}$ J.

A.5 The f/τ binding. Rearrange Equation (6.1): $\tau = f \cdot M_{He} \cdot L_v / \dot{Q}$. For $f = 10^{-9}$: $\tau = 10^{-9} \times 7.6\times10^{57} / 7.6\times10^{48} = 10^9$ s $\approx$ 32 years. For $f = 10^{-12}$: $\tau = 10^3$ s, on the order of A.5 The f/τ binding.** Rearrange Equation (6.1): $\tau = f \cdot M_{He} \cdot L_v / \dot{Q}$. For $f = 10^{-9}$: $\tau = 10^{-9} \times 7.6\times10^{57} / 7.6\times10^{48} = 10^9$ s $\approx$ 32 years. For $f = 10^{-12}$: $\tau = 10^3$ s, on the order of minutes. The circulation fraction and the period are bound together; the equilibrium fixes their product.

A.6 The adiabatic stroke. For a monatomic gas, $\gamma = 5/3$, and the adiabatic relation is $TV^{(\gamma-1)}$ = constant, with $\gamma-1 = 2/3$. The temperature ratio across a stroke: $T_{hot}/T_{cold} = (V_{max}/V_{min})^{(2/3)}$. If the breathing stroke modulates the volume by ten percent ($V_{max}/V_{min} = 1.1$), the temperature swings by $1.1^{(2/3)} \approx 1.065$ — about six percent, or 0.18 K at 2.7 K. The stroke ratio required to reach the floor from equilibrium follows the same relation and is left as the reader's exercise with the toolkit above.

A.7 Percentages. The shell equilibrium differs from the measured temperature by 0.2 percent: 2 parts in 1000, or 0.005 K. The floor offset is 0.55 K in 2.725 K — approximately 20 percent. The fourth root compresses the star-count uncertainty: a factor of two in N moves the equilibrium by $2^{(1/4)} \approx 1.19$ — nineteen percent.

A.8 The equilibrium depth. A body of density ρ_{body} immersed in the working medium at local medium density $\rho_m(r)$ experiences a restoring acceleration toward equilibrium depth:

$$a_{restore} = (\rho_{body} / \rho_m(r) - 1) \cdot g_{eff}(r) \quad (A.8.1)$$

where $g_{eff}(r)$ is the local gradient acceleration of the medium. A body at rest relative to its layer requires $\rho_{body} / \rho_m(r_{eq}) = 1$: the equilibrium depth is where the body's density matches the medium's. This is the hydrometer condition of Section 7, stated as arithmetic.

A.9 The flat rotation curve. A body coasting at tangential velocity v within its equilibrium layer requires, for equilibrium at every radius:

$$v^2(r) \propto g_{eff}(r) \cdot r \quad (A.9.1)$$

The observed flat curve, $v(r) \approx$ constant, requires $g_{eff}(r) \propto 1/r$, which the medium satisfies when:

$$\rho_m(r) \propto \ln(r) \quad (A.9.2)$$

The working gas thins logarithmically with radius. The standard account reads the same curve and concludes that enclosed mass must grow as $M(r) \propto r$ — the dark-matter halo; the bounded model reads it and concludes the working medium thins logarithmically — a profile the luminous disk approximately traces. The two readings agree on the observation and differ on the inference; the bounded inference costs no unobserved substance. For a medium denser than the galactic case, ρ_m falling faster than ln(r) steepens g_{eff}, and the Keplerian decline $v \propto r^{-1/2}$ emerges as the dilute, steep-gradient special case. The solar system sits in that regime, and the model recovers it.

A.10 The void falloff. Take the void medium density to fall as $\rho_m(r) \propto \ln(r)^{(-\beta)}$ for $\beta > 0$ — a steeper-than-logarithmic decline in a lean region, which is the definition of a void in this model. Substituting into A.9.1 through the gradient relation:

$$v(r) \propto r^{(1/2 - \beta/2)} \quad (A.10.1)$$

For $\beta = 0$ this is the flat curve; for $\beta = 1$ the Keplerian decline; for $\beta > 1$, fall-off steeper than Keplerian. The prediction of Section 9 is now a number instead of a phrase: void galaxies should exhibit rotation curves falling off as $r^{(1/2 - \beta/2)}$ with β measurably greater than the field-galaxy value. Survey rotation-curve compilations that bin galaxies by environment test the exponent directly.

A.11 Reading the equations, three steps. Name every symbol before touching a number. One operation at a time. Then translate the result into a sentence: the flat rotation curve is the statement that the working medium thins as the logarithm of radius; the void curve is the statement that it thins faster. If the sentence cannot be said, the calculation is not finished.

REFERENCES:

1. Holmes, G. The Nature of Space and Time. *International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences* 14(5), 2026. https://doi.org/10.37082/IJIRMPS.v14.i5.233218
2. Cyburt, R. H., Fields, B. D., Olive, K. A., & Yeh, T.-H. Big bang nucleosynthesis: Present status. *Reviews of Modern Physics* 88, 2016, 015004. https://doi.org/10.1103/RevModPhys.88.015004

3. Donnelly, R. J., & Barenghi, C. F. The observed properties of liquid helium at the saturated vapor pressure. *Journal of Physical and Chemical Reference Data* 27(6), 1998, 1217–1274. https://doi.org/10.1063/1.556028
4. Dong, X., Oganov, A. R., Goncharov, A. F., et al. A stable compound of helium and sodium at high pressure. *Nature Chemistry* 9, 2017, 440–445. https://doi.org/10.1038/nchem.2716
5. Holmes, G. Resonant Shell Cosmology, the Water-Matrix Lattice, and the Unified Hourglass Gravastar. *International Journal of Innovative Scientific Research* 4(3), 2026, 38–57. https://ijisr.net/ijisr/article/view/122
6. Meng, X., Piazza, B., Both, C., Barzel, B., & Barabási, A.-L. Surface optimization governs the local design of physical networks. *Nature* 649, 2026, 315–322. https://doi.org/10.1038/s41586-025-09784-4
7. Tada, K. Joule–Thomson inversion curves of helium isotopologues from theoretical virial coefficients. *International Journal of Thermophysics* 46, 2025, 48.
8. Nicastro, F., Kaastra, J., Krongold, Y., et al. Observations of the missing baryons in the warm–hot intergalactic medium. *Nature* 558, 2018, 406–409. https://doi.org/10.1038/s41586-018-0204-1
9. Fixsen, D. J. The temperature of the cosmic microwave background. *The Astrophysical Journal* 707, 2009, 916–920. https://doi.org/10.1088/0004-637X/707/2/916
10. an Dishoeck, E. F., et al. Water in star-forming regions. *Astronomy & Astrophysics* 648, 2021, A24. https://doi.org/10.1051/0004-6361/202039084
11. Arghirescu, M. The Cold Genesis of Matter and Fields. Science Publishing Group, 2015.
12. Cyburt, R. H., Fields, B. D., & Olive, K. A. An update on the big bang nucleosynthesis prediction for ^{7}Li: the problem worsens. *Journal of Cosmology and Astroparticle Physics* 2008(11), 012. https://doi.org/10.1088/1475-7516/2008/11/012
13. Krasznahorkay, A. J., Csatlós, M., Csige, L., et al. Observation of anomalous internal pair creation in ^{8}Be: A possible indication of a light, neutral boson. *Physical Review Letters* 116, 2016, 042501. https://doi.org/10.1103/PhysRevLett.116.042501
14. Israel, W. Singular hypersurfaces and thin shells in general relativity. *Il Nuovo Cimento B* 44, 1966, 1–14. https://doi.org/10.1007/BF02710419