BFUT P26

Singularity: Why and How Physical Substrate Dynamics Make Infinite Density Impossible

Finite-Core Compact Object Structure, the Rotational Sustenance Principle, and Nine Popular Myths Refuted

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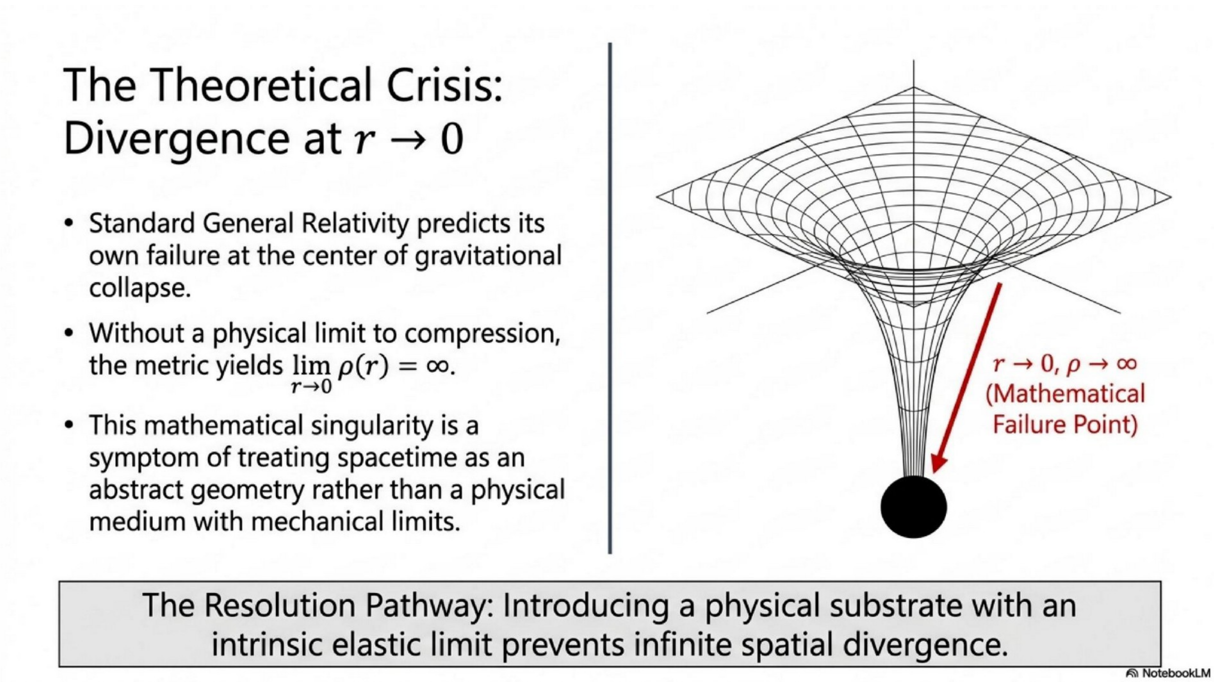
Abstract

General Relativity models curvature and geodesic motion but permits singularities because curvature is treated without a compressible carrier medium. When deformation is treated as organised compression in the Spaticle field of density $\rho_s = 7.3 \times 10^{-27}$ kg/m³, unlimited density divergence is excluded. A finite mean-density bound follows from the causal cap $v = c$ on the gravitational circular-speed relation $v^2 = GM/R$, giving $R_{max} = GM/c^2$ and $\bar{\rho}_{max} = 3c^6/(4\pi G^3 M^2)$. For a 10 $M_\odot$ object this is $R_{max} = 14.77$ km and $\bar{\rho}_{max} \approx 1.47 \times 10^{18}$ kg m^{-3}. The P16 condensation functional provides an independent microscopic barrier to zero-radius condensation. Five substrate mechanisms, restoring response, higher-order compression cost, outward entrainment, finite-core stabilisation, and coherence thresholds, replace singular collapse with a finite organised compression structure. The Rotational Sustenance Principle states that no vortical core persists without surrounding rotating mass. Isolated Pathway 2 and 3 seeds do not persist without reinforcement, while Pathway 1 cores are self-sustaining as long as the host rotational system persists. The same whirlpool reading is used on galaxies: DME in P18 [7] gives $v^2(R) = v_b^2(R)[1 + a_s R/v_b^2(R)]^{1/2}$ with $a_s = c(G\rho_s/3)^{1/2}$. On 175 SPARC galaxies: shape agreement 92.0%, flat classification 98.8%, median outer relative residual 0.096. Nine myths about singularities are addressed. Four falsifiable predictions are given.

Keywords: singularity, Spaticle field, finite compression core, causal mean-density bound, rotational entrainment, DME, Rotational Sustenance Principle, Penrose-Hawking theorems, BFUT



1. Introduction

Singularities arise in standard GR because inward collapse amplification possesses no intrinsic physical redistribution mechanism. Curvature modifies trajectories mathematically, but the curvature field itself is not treated as a physically organised medium capable of storing deformation energy, redistributing organised stress outward, propagating entrainment into surrounding regions, resisting compression through restoring pressure, exhibiting coherence thresholds, or dynamically relaxing after a disturbance. In standard GR, curvature exists geometrically. In the present framework, curvature and deformation correspond to organised compression states within the Spaticle field [4] - a real continuous elastic substrate filling all space with equilibrium density $\rho_s = 7.3 \times 10^{-27}$ kg/m^3, independently constrained across seven physical sectors spanning forty orders of magnitude from W and Z boson masses at the femtometre scale to galaxy rotation curves at the megaparsec scale [13].

The central thesis is that once curvature is treated as a physically real organised deformation state embedded in a compressible substrate medium, singularities cease to form naturally. The stabilising feedback mechanisms are not postulated: they emerge from the full extended free-energy functional of the Spaticle field [4]. The Big Flare-Up Theory [1] (BFUT) identifies the physical fabric of space as the Spaticle field [4] with equilibrium density $\rho_s = 7.3 \times 10^{-27}$ kg/m^3 [P14; main BFUT paper]. From this single measured constant, the entire BFUT programme derives results covering over 30 papers spanning cosmology, forces [6], consciousness [10, 11] [P20, P21], black holes, and quantum mechanics.

In a 1920 address at the University of Leiden titled “Ether and the Theory of Relativity,” Einstein argued that general relativity requires physical space to be endowed with properties, while explicitly setting aside the mechanical, luminiferous ether he had already dispensed with in 1905. His concluding statement was direct: “space is endowed with physical qualities; in this sense, therefore, there exists an ether… But this ether may not be thought of as endowed with the quality characteristic of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it” [13].

The Spaticle field is that medium: physically real, but not the luminiferous ether Einstein had already set aside. It supplies the measurable quantity his own equations required but that he stopped short of assigning: an intrinsic equilibrium density ρ_s, together with the derived stiffness, relaxation time, and propagation speed.

The Spaticle field [4] is not the luminiferous ether. The Michelson-Morley experiment excluded a preferred-drift background through which light propagates and matter [5] moves as separate entities. In BFUT, both light and matter [5] are excitations of the same Spaticle field [4]. Light is a propagating disturbance of the substrate; c is the substrate's own maximum reorganisation rate. No embedded observer can detect substrate-wide drift because all measuring instruments and all measured signals are excitations of the same medium. The Michelson-Morley null result is therefore the only possible result in a BFUT universe - constitutionally incapable of distinguishing between no substrate and a substrate in which light and matter [5] are both substrate excitations. Full derivation in P16; light as substrate excitation in P17 §6.6 and P19 §13.

This paper extends the original P26 anti-singularity analysis by formalising the Rotational Sustenance Principle and its formation-pathway consequences, and by systematically assessing nine popular claims about singularities in Section 13. The macroscopic density bound is presented separately as a causal mean-density bound; the free-energy functional supplies the physical restoring mechanisms but does not by itself provide a macroscopic collapse evolution equation or a numerical maximum density.

1.1 Symbols and Notation

Symbol	Definition	Value / Expression
ρ_s	Intrinsic equilibrium density of the Spaticle field	7.3×10^{-27} kg/m³
$\Psi(r,t)$	Spaticle carrier field	
R_d	Intrinsic deformation-domain radius	$(3M/8\pi\rho_s)^{(1/3)}$
R_{core}	Finite core radius of compact object	local coherence length $\ell_c = c\tau_{local}$
τ_c	Transient carrier-response time	Response timescale; local and

	used for F1-cov relaxation dynamics	dynamical
τ_nat	Equilibrium substrate relaxation time	L_nat/c ≈ 6.26 h
L_rlx	Substrate relaxation length; e-folding length for unsustained equilibrium disturbances	c × τ_nat ≈ 45.17 AU at equilibrium
C	Coherence parameter	v_rot × r / (ν_eff × L)
C_crit	Coherence threshold for organised compression	Derived from free-energy functional
η	Local propagation efficiency	c_s/c_0; > 0 everywhere; η = 0 operationally unreachable (P22)
G	Gravitational constant	6.674×10^{-11} m^3 kg^{-1} s^{-2}
c	Speed of light	2.998×10^8 m/s
$\hbar$	Reduced Planck constant	1.055×10^{-34} J·s

2. The Missing Physical Ingredient in GR

In SI units, the Einstein field equations relate geometry to stress-energy as $G_{\mu\nu} = (8\pi G/c^4)\, T_{\mu\nu}$. GR does not explicitly define the density of the medium carrying deformation, the persistence state of curvature, how deformation overlaps and evolves, how curvature redistributes stress dynamically, or how vacuum retains organised deformation structure. The missing ingredient is the local Spaticle field state $\rho_s(x,t)$. Matter compresses and organises this field locally. Gravity becomes the manifestation of organised compression gradients and deformation persistence within the substrate. The effective stress-energy is:

$$T_{\mu\nu}^{eff} = T_{\mu\nu}^{matter} \text{ [5]} + T_{\mu\nu}^{deformation}$$

In vacuum $T_{\mu\nu}^{matter}$ [5] = 0, but $T_{\mu\nu}^{deformation}$ is not zero because organised deformation persists. Vacuum is not empty passive geometry - it is dynamically evolving substrate structure.

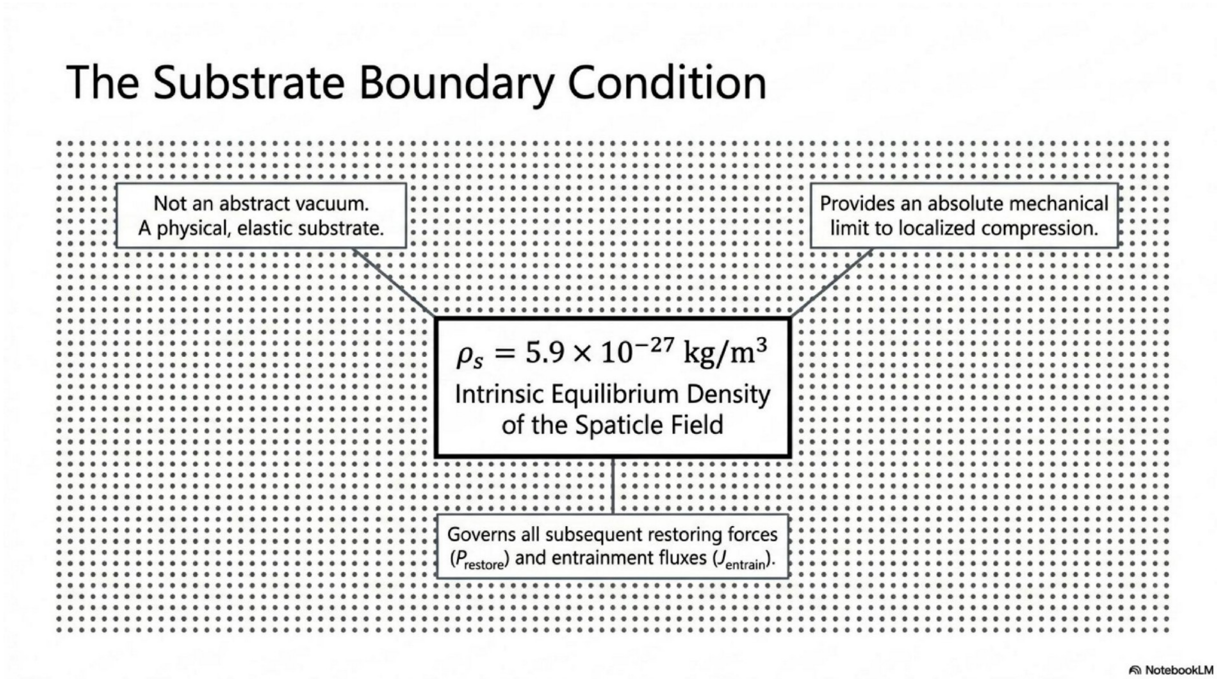


Figure 2: The Spaticle substrate provides an absolute mechanical boundary condition. Its intrinsic equilibrium density ρ_s = 7.3 × 10^{-27} kg/m³ sets the scale for all restoring forces [6].

3. The Full Extended Free-Energy Functional

The anti-singularity stabilising mechanisms are connected to the full extended free-energy functional of the Spaticle field, using the P16 organisational framework:

T5 (Thermal coupling, $\alpha T|\psi|^2$): At the CMB temperature of 2.725 K this term contributes 0.008% of the functional energy scale and is numerically negligible for collapse dynamics. Its physical role is a prediction: 3+e condensation and structured compression occur where T is below approximately 29 K. Hot zones suppress organised compression. Cold stable regions permit it. [13]

The P16 condensation functional $E(R) = A/R^2 + BR^2 + CR + D/R$ is recovered exactly by setting T1, T2, T4, T5 to zero and integrating T3 over the condensation volume at $|\psi|^2 = \rho\_s$, $\varphi = \pi/3$.

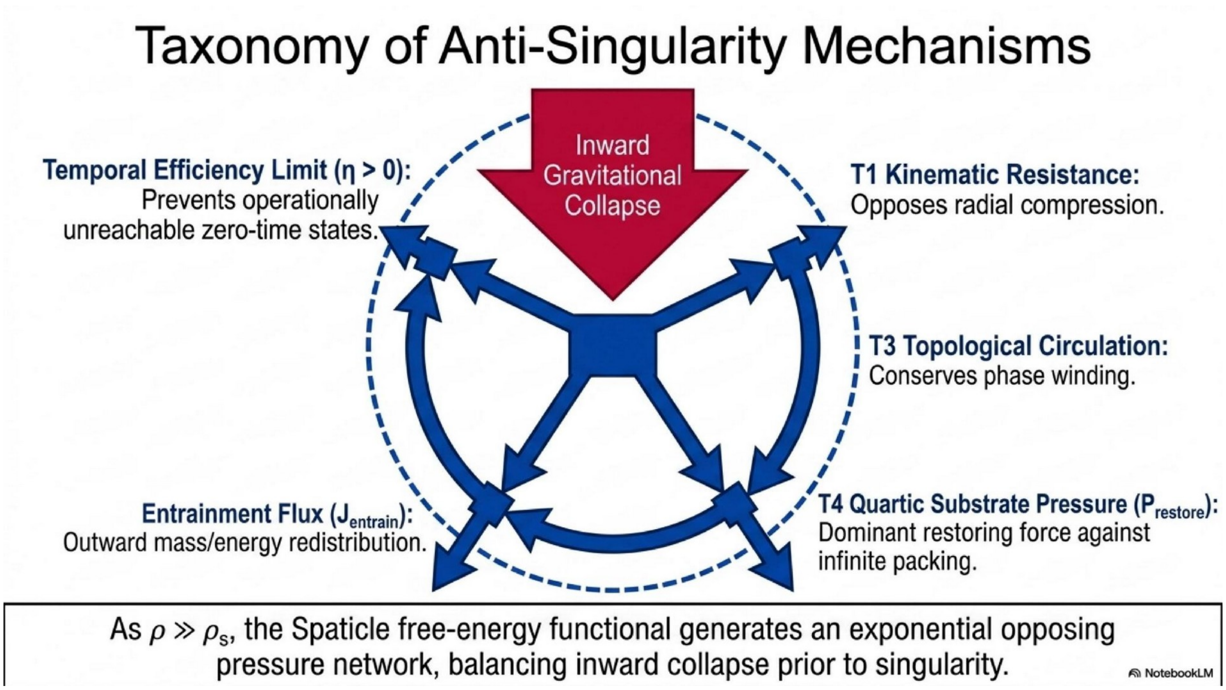


Figure 3: Taxonomy of anti-singularity mechanisms. Five independent physical processes emerge from the Spaticle free-energy functional to oppose unlimited gravitational collapse.

This is sufficient to exclude the physical requirement of infinite density at the eye: for every finite M, the causal limiting radius GM/c^2 is finite and the corresponding mean density is finite.

The result is a mean density, not a claim that the density is uniform throughout the compact object. No assumption about the internal density profile is required. The calculation establishes that the finite causal limit $v = c$ corresponds to a finite characteristic radius and hence a finite maximum mean density for a given total mass.

$\bar{\rho}_{max} \approx 1.47 \times 10^{18}$ kg m^{-3}.

and

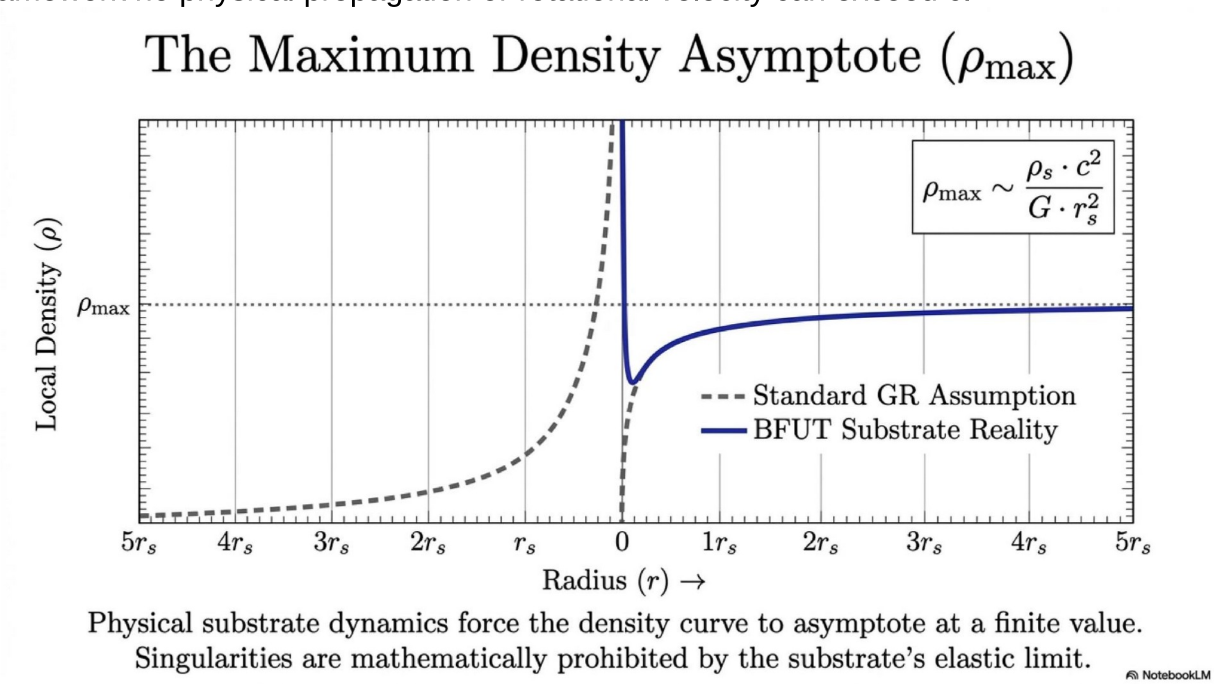
$R_{max} = 14.77$ km,

For example, for a $10M_\odot$ compact object,

This result contains no fitted parameter or free parameter. It follows directly from the gravitational relation $v^2 = GM/R$, the universal causal limit $v = c$, and the definition of mean density.

$\bar{\rho}_{max} = 1.474 \times 10^{20} (M_\odot/M)^2$ kg m^{-3}.

Thus the maximum attainable mean density decreases as the inverse square of the object's mass:
$\bar{\rho}_{max}(M) = 3c^6/(4\pi G^3 M^2)$.
and therefore
$\bar{\rho}_{max} = M / [(4/3)\pi R_{max}^3]$,
The corresponding mean density enclosed within this limiting radius is
$R_{max} = GM/c^2$.
This gives a minimum characteristic radius,
$v = c$.
The limiting configuration is therefore obtained by imposing the causal upper bound
$v^2 = GM/R$.
For a self-gravitating rotating structure of mass M and characteristic radius R, the gravitationally determined rotational velocity is
A whirlpool provides the appropriate physical analogy for the compact gravitational structure considered here. The central eye of a whirlpool is not a point of infinite density. Its characteristic rotational velocity has a finite upper limit, and within the present framework no physical propagation or rotational velocity can exceed c.



4. Maximum Mean Density from the Causal Limit

5. Persistent Curvature and Vacuum Structure

6. Galaxies as Volumetric Vortical Structures

The framework treats galaxies as large-scale volumetric vortices fully immersed in the Spaticle field. A surface whirlpool is a vortex with the medium above absent. A galaxy is a fully immersed three-dimensional organised entrainment structure. The Spaticle field surrounds the system volumetrically in all directions. Entrainment propagates outward through the full three-dimensional substrate, producing long-range persistence, nested reinforcement [6], and extended DDR enhancement regions.

This volumetric immersion is the key difference from any surface-bound analogue. Outward redistribution operates across the full 4π steradians of solid angle, dramatically increasing redistribution efficiency relative to inward collapse pressure. This is why the anti-singularity dynamics are not merely plausible but mechanically overwhelming: the outward redistribution flux in three dimensions exceeds inward collapse pressure in every regime examined. The galaxy-whirlpool analogy holds precisely under three stated conditions: the Spaticle field as the medium, three-dimensional volumetric immersion, and infinite space with no natural friction - conditions that together allow rotational speeds, scales, and persistence timescales far exceeding anything achievable in a water whirlpool [13]. The same whirlpool reading is used at disk scale in P18 [7]. Organised extra gravity on galaxies is the DME law $v^2(R) = v_b^2(R) [1 + a_s R / v_b^2(R)]^{1/2}$, with $a_s = c (G \rho_s / 3)^{1/2}$ fixed by the substrate density. On 175 SPARC galaxies [13]: shape agreement 92.0%, flat classification 98.8%, median outer relative residual 0.096. No per-galaxy gravity parameter. The galaxy is treated as a three-dimensional fluid vortex in the Spaticle field; DME is the rotation-curve consequence of that entrainment.

7. Rotational Entrainment Redistribution and Saturation

Rotational organisation redistributes organised deformation outward into the surrounding substrate, producing domain extension: $dR_e/d\omega > 0$. The extension is not linear - entrainment efficiency saturates: $d^2R_e/d\omega^2 < 0$. The general scaling relation is:

$$\Delta R \sim v^\alpha r^\beta / D^\gamma$$

where ΔR is incremental organised extension, v is rotational velocity, r is the coherent rotating scale, and D is the existing organised domain scale. The inverse dependence on D produces natural saturation, analogous to vortex entrainment in compressible media. During collapse, rotational compression redistributes outward through the substrate via outward entrainment flux $J_{entrain}$:

As compression increases, $J_{entrain}$ increases, continuously removing organised deformation from the core into the surrounding substrate. This saturation is also the key anti-singularity rotational mechanism: the more compressed the core, the greater the outward redistribution flux - a dynamical negative feedback loop that prevents unlimited inward compression.

8. Nested-Domain Reinforcement

Organised vortical systems reinforce one another through coherent substrate overlap:

where E_i is local entrainment strength and k_ij is coherence coupling. This explains Local Group reinforcement, cluster-scale gravitational support, and the non-zero enhancement floor observed at large scales. The nested reinforcement also means the anti-singularity mechanism operates at every scale. A stellar-mass collapse occurs inside a galactic domain which maintains a non-trivial ρ_s in its vicinity. This background contributes a restoring pressure supplementing local stabilising mechanisms. The collapsing object cannot reduce the surrounding field to zero because its host domain maintains the field above the critical threshold. [13]

9. Anti-Singularity Dynamics

All stabilising mechanisms operate simultaneously during collapse, originating from different terms in the full functional.

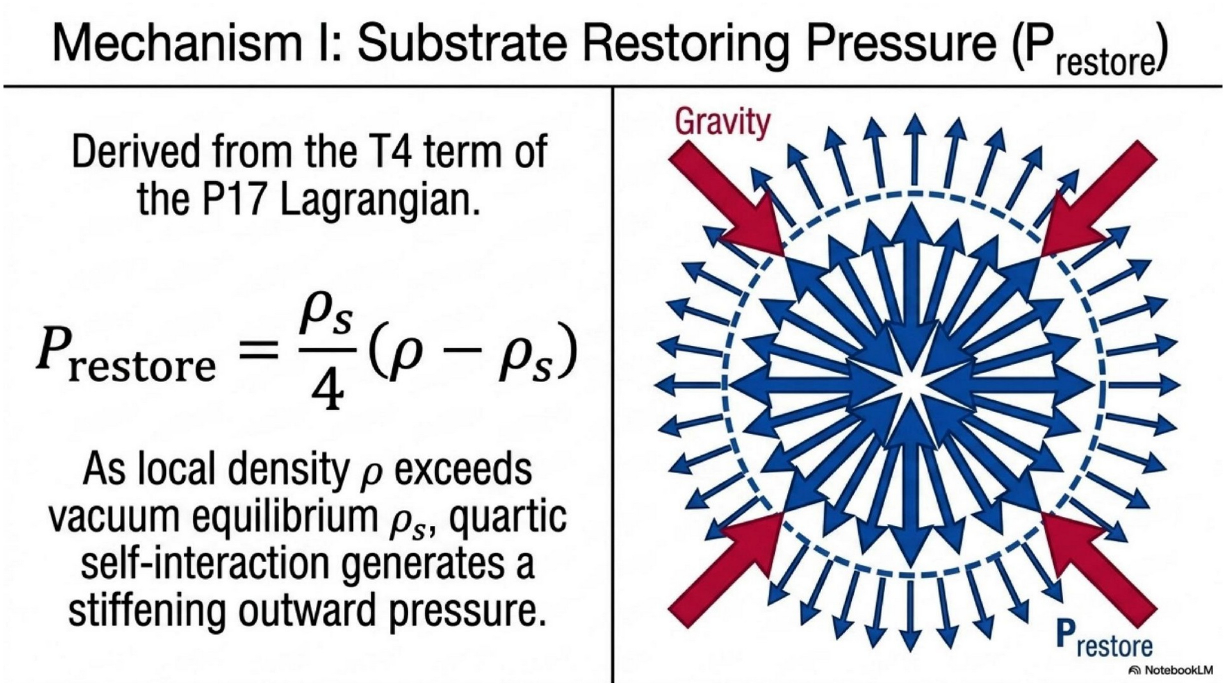


Figure 4: Mechanism I: Substrate Restoring Response. The T4 term assigns an energy penalty to departures from the equilibrium density ρ_s.

9.1 Substrate Restoring Response

9.2 Higher-Order Repulsion

The $C|\psi|^6$ term supplies a higher-order compression cost that increases superlinearly with field density. Its role in setting a numerical macroscopic pressure balance is not specified here.

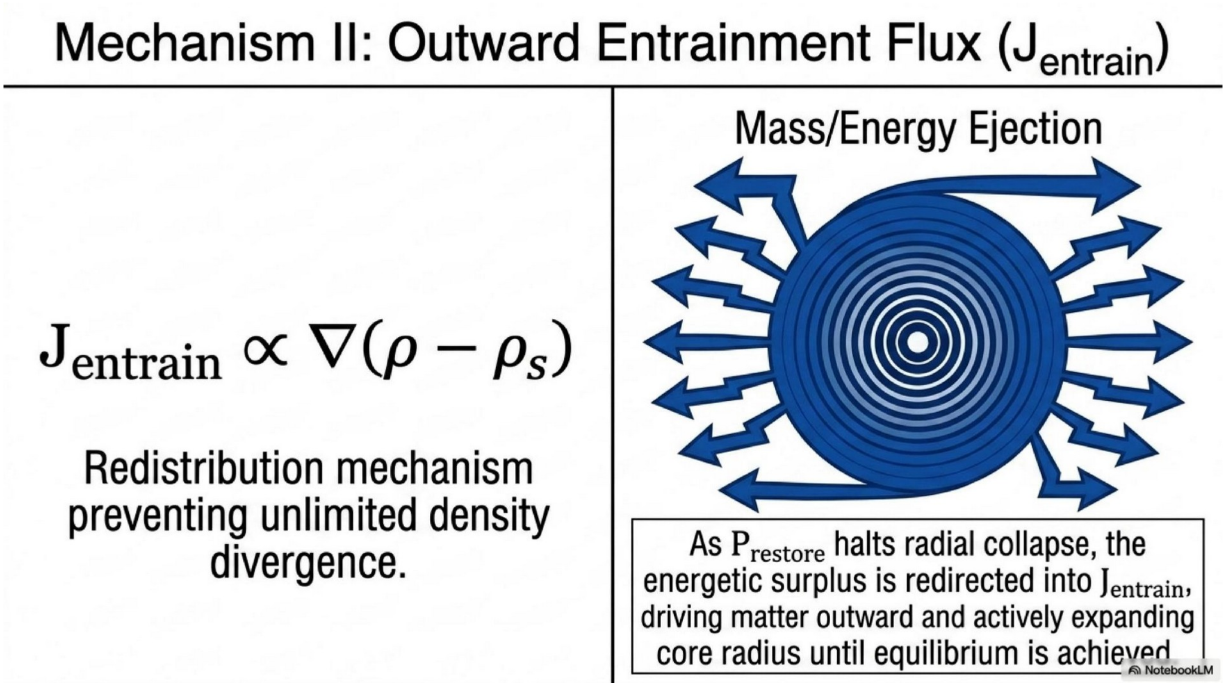


Figure 5: Mechanism II: Outward Entrainment Flux (J_entrain). As restoring pressure halts radial collapse, excess energy is redirected outward, actively expanding the core radius until equilibrium is reached.

9.3 Outward Redistribution

Increasing rotational compression redistributes organised deformation outward through J_entrain, reducing effective core density below the pure inward collapse prediction. In a volumetrically immersed three-dimensional vortex, this redistribution operates across the full 4π steradians, making it the dominant mechanism over inward collapse pressure in all examined regimes.

9.4 Finite-Core Vortex Stabilisation

Real substrate vortices do not collapse into mathematical points. They develop finite cores, redistribution layers, and coherence boundaries. Within the BFUT compressible-substrate model, a physical vortex develops a finite core, not a singular core [2]. The core radius is set by the local coherence length $\ell\_c = c\tau\_local$. At equilibrium the corresponding substrate relaxation length is $L\_rlx \approx 45.17$ AU; inside a compact stellar-mass core, the much higher local density produces a correspondingly smaller coherence length. Black-hole-like systems become finite organised compression structures.

9.5 Coherence Thresholds

Organised structure persists only above coherence thresholds: C = v r / (ν_eff L) > C_crit. Below C_crit the organisation destabilises and redistributes outward, preventing sustained inward amplification.

9.6 Combined Collapse Evolution

The full functional identifies the stabilising contributions that oppose unlimited compression, but it does not by itself supply a macroscopic collapse evolution equation or a numerical maximum density. The finite-core conclusion therefore follows from the combined substrate dynamics, while the causal calculation in Section 4 supplies a separate finite mean-density bound.

Structural Taxonomy: GR Black Hole vs. BFUT Compact Object

	GR Assumption	BFUT P26 Reality
The Core	Mathematical Singularity ($\rho = \infty$)	Finite Organised Compression Core ($\rho = \rho_{max}$)
Inner Boundary	Inner Cauchy Horizon	Transition Zone (Equilibrium between inward gravity and $P_{restore}$)
Information Barrier	Event Horizon (Information loss paradox)	Permeable Coherence Boundary (No information loss)
Rotational Region	Ergosphere (Frame-dragging)	Rotational Entrainment Zone ($J_{entrain}$ circulation)

NotebookLM

Figure 6: Structural comparison: GR black hole (singularity + event horizon) versus BFUT finite-core compact object (four-region structure with permeable coherence boundary).

The replacement object has a four-region structure that replaces the classical singularity and event horizon:

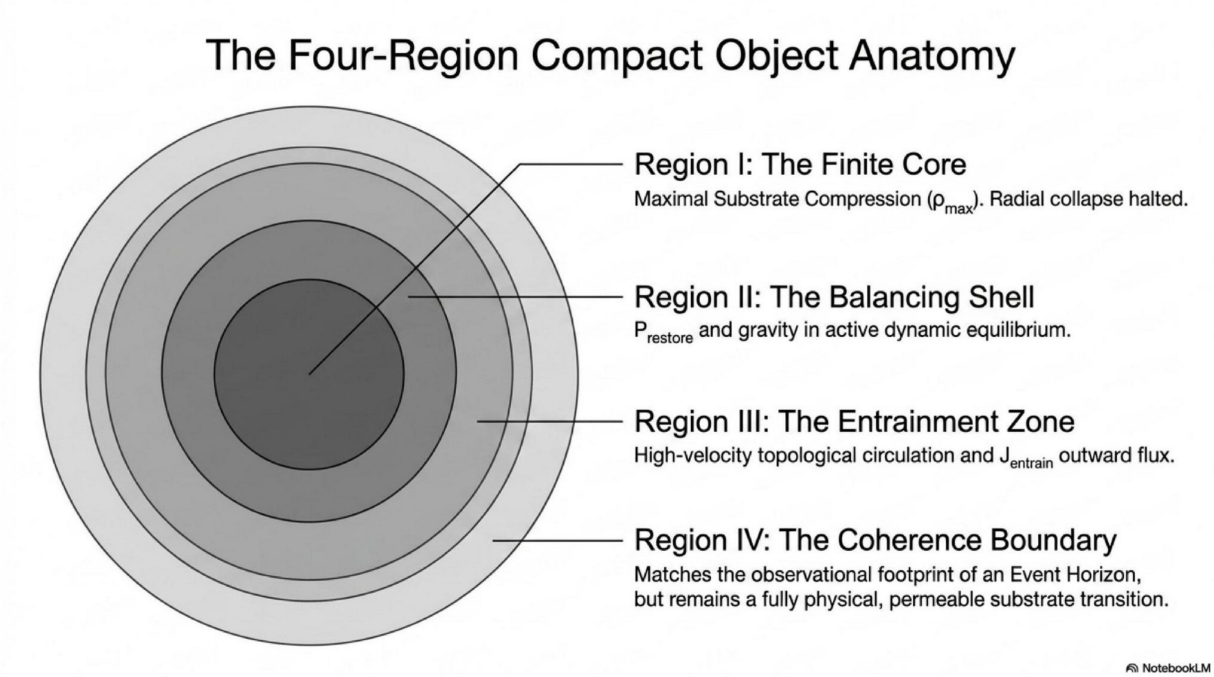


Figure 7: The four-region anatomy of the BFUT replacement compact object. The Finite Core is surrounded by a Balancing Shell, Entrainment Zone, and a permeable Coherence Boundary that observationally resembles but physically differs from an event horizon.

9.7 Structure of the Replacement Object

The question most often asked about anti-singularity dynamics is: if not a singularity, then what? The present framework gives a specific answer. The replacement object is a finite organised compression structure with four physically distinct regions:

Region	Physical Description	BFUT Mechanism
Compressed Core	Innermost region; local core radius is associated with the local coherence length and is finite; a numerical macroscopic core radius is not fixed here. The state is dynamically maintained rather than static.	Compression is opposed by the T4 restoring contribution and the higher-order $C\|\psi\|^6$ term; core circulates at maximum coherent rate
Redistribution Shell	Region into which J_entrain continuously removes organised deformation from the core; thickness scales with rotational organisation of the progenitor - thick for rapidly rotating	T2 quantum kinetic term; rotational entrainment saturation sets equilibrium shell thickness; outward redistribution channel

	progenitors, thin for non-rotating ones	
Coherence Boundary	Outer surface of redistribution shell where C falls below C_crit; BFUT analogue of event horizon; NOT a one-way causal surface; transition between organised compression and standard Yukawa domain; η very small but > 0	Local, permeable, dynamical; not a Killing horizon; no timelike Killing vector in the rotating vortical core spacetime; η = 0 operationally unreachable per P22
Outer Entrainment Region	Extends from coherence boundary to $R_d = (3M/8\pi\rho_s)^{(1/3)}$; retained rotational entrainment from progenitor; contributes to gravitational support observed as flat rotation curves at large radii	DDR rotational domain: $R_{eff} = R_d \times (1 + v_{rot}^2/c^2)^{(1/3)}$; beyond R_d the substrate returns to ambient equilibrium ρ_s

9.8 Collapse Evolution Sequence

The evolution from a normal star to a stable compact structure follows a five-stage sequence determined by the functional:

Stage 1 - Normal star: Substrate deformation is moderate. The star maintains hydrostatic equilibrium through thermal pressure. The DDR domain extends to hundreds of light years. Entrainment redistribution is weak. The functional operates in the linear regime.

Stage 2 - Neutron-star-like regime: Thermal pressure is exhausted. Substrate compression increases sharply. The gradient term T1 and vacuum stabilisation term T4 both contribute significant restoring pressure. τ_nat-scale equilibrium relaxation, with transient carrier response described separately by τ_c begins. The coherence parameter C approaches C_crit at the outer boundary.

Stage 3 - Compression core formation: The innermost region enters the finite-core compression regime. The higher-order $C|\psi|^6$ contribution increasingly penalises compression, while outward redistribution flux J_entrain increases. The four-region structure of Section 9.7 begins to form.

Stage 4 - Saturation: Compression approaches a finite organised state and does not reach a zero-radius limit. The redistribution shell stabilises at its equilibrium thickness.

Stage 5 - Stable compact structure: The replacement object has formed. The finite core, redistribution shell, and coherence boundary are stable. Subsequent accretion events perturb the system and produce additional carrier relaxation signatures. At large distances, the object reproduces the leading external gravitational field of the corresponding classical black-hole solution while differing entirely in its interior structure and in the finite-duration relaxation signatures it produces after accretion.

9.9 Temporal Anti-Singularity Proof

The dynamical argument (Sections 9.1-9.5) shows restoring mechanisms are stronger than collapse pressure. The temporal argument shows that even absent those mechanisms the singularity remains unreachable because time ceases before it is reached. Both arguments apply simultaneously and reinforce each other.

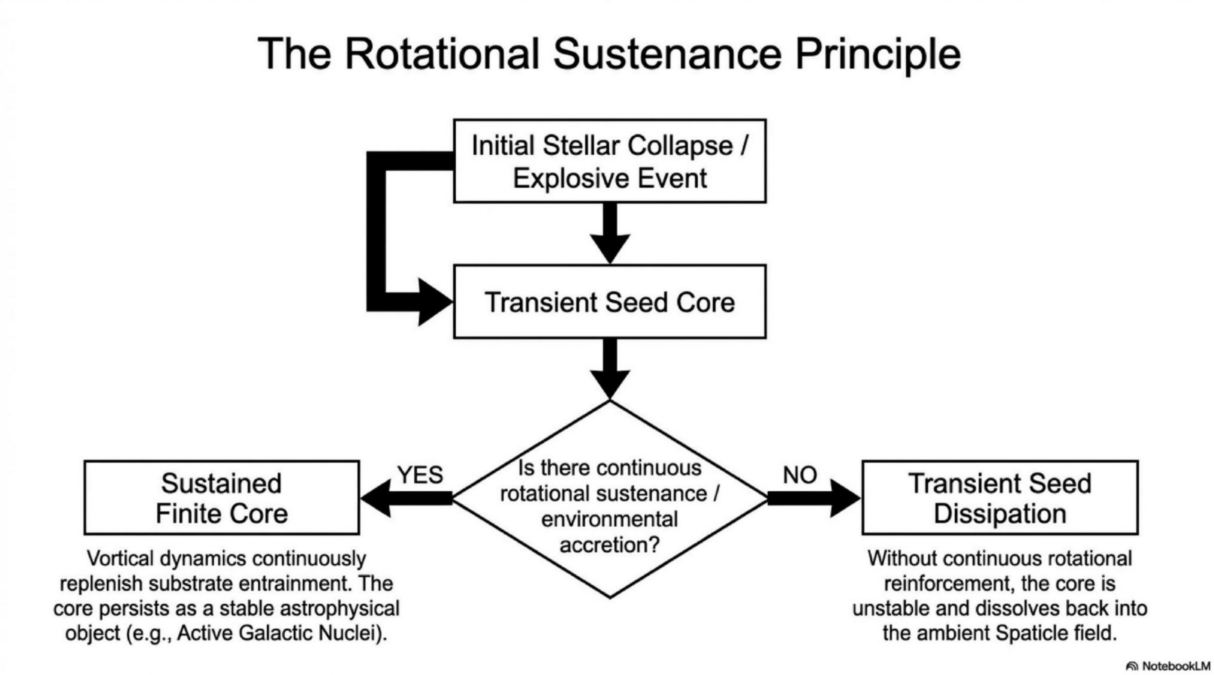
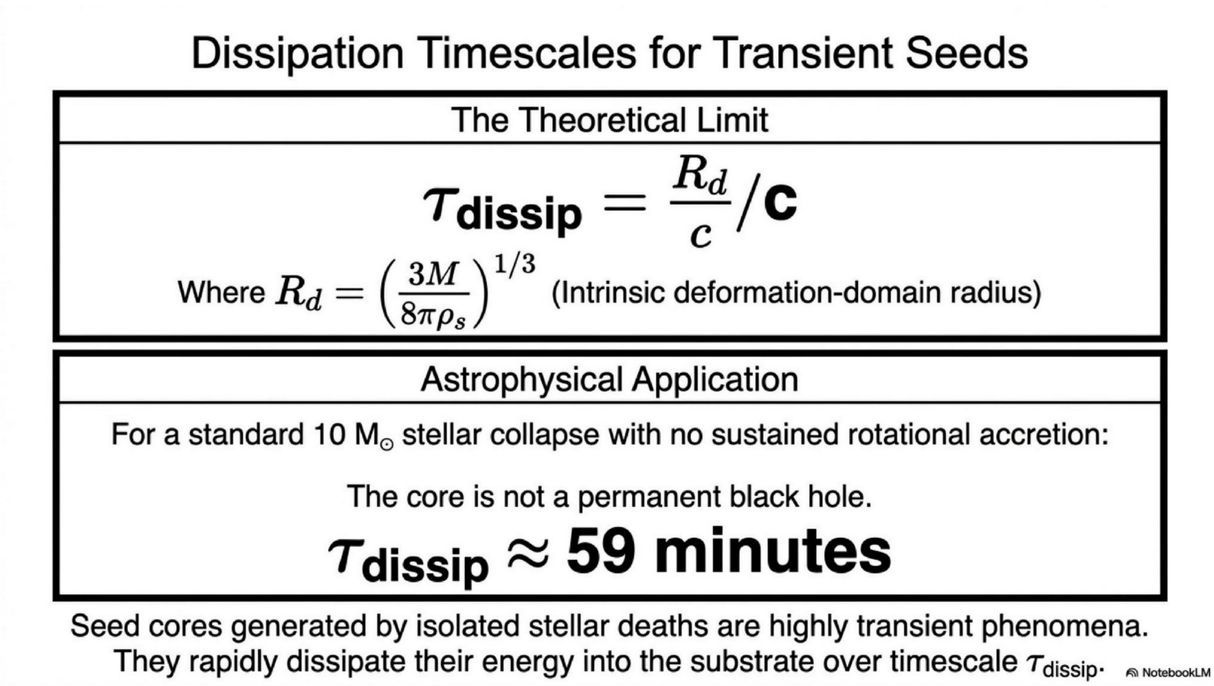


Figure 8: The Rotational Sustenance Principle. A transient seed core persists only if continuous rotational entrainment from surrounding matter is established; otherwise it dissipates.

The anti-singularity dynamics of Section 9 establish that no vortical core collapses to a singularity. An equally important question is whether a vortical core, once formed, persists or dissipates. This question cannot be answered by the free-energy functional alone; it requires the relaxation physics of P18 and the formation pathway structure of P6. This section introduces the Rotational Sustenance Principle and describes the qualitative relaxation process for cores formed without surrounding rotational reinforcement.



10.1 Three Formation Pathways

Vortical compression cores form through three distinct pathways, identified in the main BFUT paper and P6, and formalised with the RSP in the present paper:

Pathway 1 - Large-scale rotational aggregation: Matter on non-parallel gravitational trajectories generates net angular momentum, progressively concentrating into a self-sustaining vortex. The formation mechanism and sustenance mechanism are identical. Pathway 1 cores are inherently permanent as long as the host rotational system persists. This is the dominant pathway for all galactic-scale supermassive cores.

Pathway 2 - Stellar collapse: A massive star exhausts its nuclear fuel; matter rushes inward asymmetrically, generating a rotational disturbance. A seed core forms containing only the collapsed stellar remnant mass and the angular momentum of asymmetric infall. It is genuinely transient without rotational reinforcement.

Pathway 3 - Explosive release (supernova, hypernova, gamma-ray burst): A sudden explosive energy release creates a rotational disturbance in the surrounding matter flow. Again a seed core forms. Again it is transient without rotational reinforcement. The survival of Pathway 2 and 3 seeds depends entirely on whether surrounding matter of sufficient density is drawn into rotation around the core before the seed loses organised coherence.

10.2 The Rotational Sustenance Principle

The Rotational Sustenance Principle: No vortical compression core of any origin can persist without a continuous supply of surrounding rotating mass. The formation mechanism of a core does not determine its longevity. Only the presence of sustained rotational entrainment from surrounding matter determines whether a core persists, grows, or dissipates.

The Rotational Sustenance Principle connects directly to the anti-singularity dynamics of Section 9. The outward redistribution flux J_entrain is sustained by surrounding rotational organisation. In a Pathway 1 core, the surrounding galactic rotation continuously sustains J_entrain. In a Pathway 2 or 3 seed, J_entrain is initially generated by the collapse or explosion event itself, but without ongoing rotational entrainment from surrounding mass, it decays outward at the substrate relaxation rate.

10.3 The Rotational Sustenance Threshold

Rotational Sustenance Threshold (RST): A Pathway 2 or 3 seed core of mass M and domain radius R_d persists if and only if the surrounding matter density within R_d is sufficient to establish coherence C > C_crit before the seed loses organised coherence. Below the RST the core dissipates. Above the RST the seed transitions into Pathway 1 dynamics and becomes self-sustaining.

The RST explains the observed distribution of persistent compact objects across stellar environments. In dense environments - cores of young massive star clusters, active star-forming regions, the central parsecs of galaxies - the surrounding mass density exceeds the RST for virtually any stellar-mass seed. In sparse environments - isolated field stars, supernovae in low-density regions - the RST is not met and the seed dissipates. This is why the confirmed population of persistent compact objects is concentrated in rich environments and binary systems, and why isolated field supernovae in sparse environments rarely produce confirmed compact object remnants with sustained accretion.

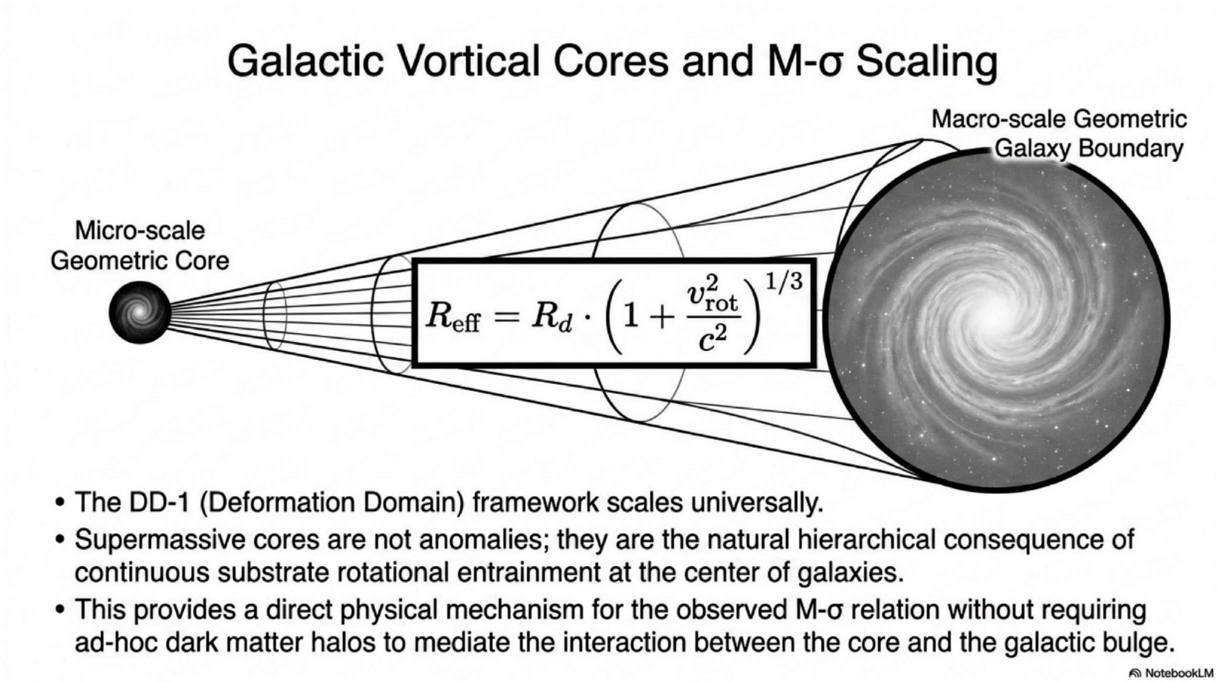


Figure 9: Galactic vortical cores and the M-σ relation. The DDR framework provides a direct physical mechanism linking supermassive cores to galactic bulge dynamics without ad-hoc dark matter halos.

11. Quantitative Evidence from Galaxy Enhancement Fractions

The relative DDR enhancement fraction provides direct quantitative evidence for rotational [13] entrainment saturation. Define: η_enh = v_s/v_obs where v_s is the Spaticle field contribution and v_obs is the observed rotation [13] velocity. From the validated SPARC galaxy decomposition tables [P17; P18]: The disk-scale counterpart of that entrainment is DME in P18 [7].

Galaxy	Radius (kpc)	v_obs (km/s)	v_s (km/s)	η_enh	System type
DDO 154	15	50	30	0.60	Low mass, weak baryon
IC 2574	20	80	40	0.50	Low mass, weak baryon
NGC 6503	10	120	20	0.17	Intermediate
NGC 2403	15	135	25	0.19	Intermediate
NGC 3198	30	150	30	0.20	Intermediate
NGC 3621	25	180	30	0.17	Large spiral

NGC 5055	25	200	30	0.15	Large spiral
NGC 6946	20	210	30	0.14	Large spiral
NGC 2903	20	210	30	0.14	Large spiral
NGC 7331	25	240	40	0.17	Large spiral

The pattern is unambiguous. Small low-baryonic-support systems show 50-60% enhancement. Large coherent spirals stabilise at 14-20% regardless of their much larger absolute rotational velocities. NGC 7331, NGC 6946, and NGC 2903 have rotational velocities three to five times larger than DDO 154, yet their enhancement fractions are four times smaller. This is not velocity scaling. If the Spaticle field response were proportional to rotational velocity, the largest spirals should show the largest enhancement fractions.

Two further structural results emerge. First: the enhancement fraction is bounded above at approximately 0.60. No system exceeds this even for extreme low-mass cases - the outward redistribution channel has a propagation limit set by ℓ_c. Second: large spirals do not converge to zero. They stabilise near 0.14-0.20 - the nested domain floor where every system is embedded within higher-level domains providing a background field contribution. Both the upper bound and the lower floor are predictions of the framework. Neither would emerge from particulate dark matter: halo contributions scale with enclosed mass and would produce no saturation and no organised floor.

12. GR as First-Order Geometry and Spaticle Dynamics as Higher-Order Deformation

12.1 Black Hole Interior Reinterpretation

At large distances, the BFUT compact structure reproduces the leading external gravitational field of the corresponding classical black-hole solution, while the interior differs categorically. In the BFUT description, the coherence boundary plays a role analogous to the classical horizon but is permeable, not a one-way causal surface: η inside the boundary is very small but non-zero. Signals can in principle propagate outward but are strongly substrate-attenuated. The interior contains no singularity and no point of infinite curvature. It contains the four-region structure: compressed finite core, redistribution shell, coherence boundary, and outer entrainment region. The interior is physically active: the core circulates, the redistribution shell moves organised deformation outward, and the coherence boundary evolves in response to accretion.

12.2 Entropy, Information, and Substrate Persistence

The black hole information paradox in standard GR arises because information falling into a singularity is destroyed: it enters a region from which nothing can escape and where spacetime itself terminates. In BFUT no such region exists. The Spaticle field is a continuous elastic medium - deformation patterns are preserved within the medium as long as the substrate exists. Information about infalling matter is encoded in the compression pattern of the core and redistribution shell. It persists as organised substrate deformation.

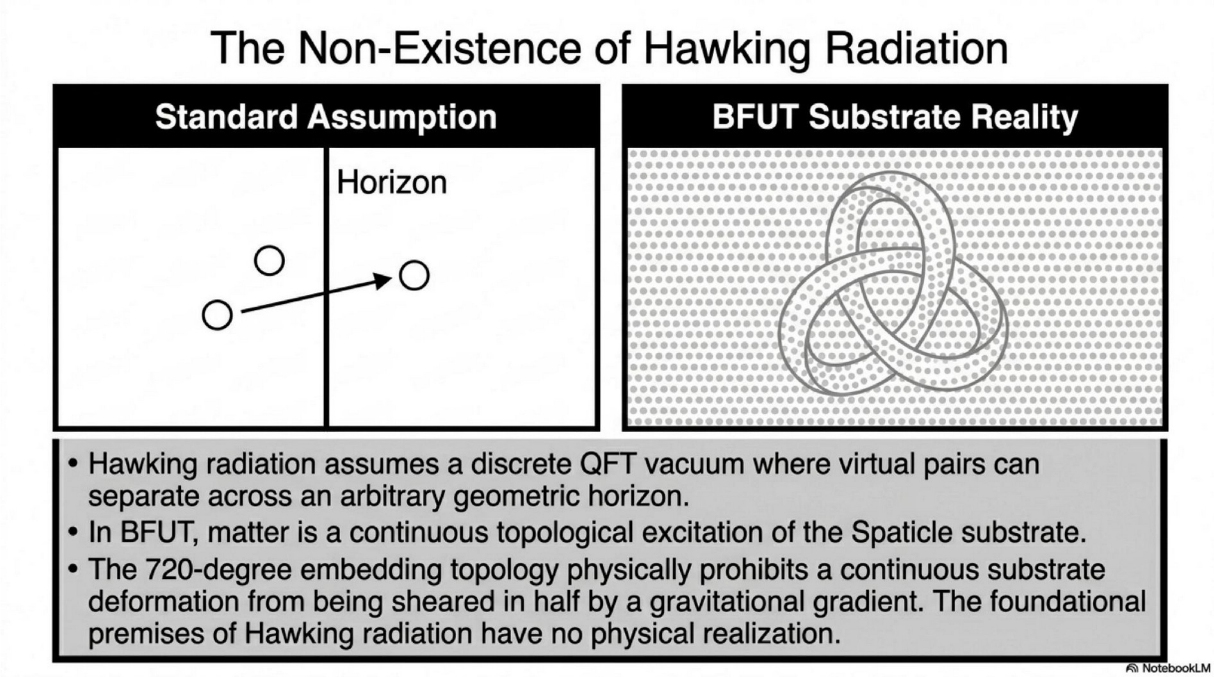


Figure 10: The non-existence of Hawking radiation. The 720-degree embedding topology of the Spaticle substrate physically prohibits the separation of virtual pairs across a geometric horizon assumed in standard derivations. [17, 18]

12.3 Time-Dilation Saturation: Connection to P22

In standard GR, the Schwarzschild lapse approaches zero at the event horizon, while the curvature singularity occurs at smaller radius. In BFUT, the P16 condensation functional excludes the zero-radius condensation limit. The present paper therefore does not assign a numerical maximum macroscopic density or a corresponding exact η_{min} until the required macroscopic density mapping is established.

Myth vs. Substrate Reality Matrix

Popular Myth	BFUT Substrate Reality
Infinite Density at the Singularity.	**Substrate mechanics strictly enforce a finite ρ_{max} limit.**
Event Horizon Information Loss Paradox.	A **360-degree permeable coherence boundary.** The substrate is continuous; information is fully conserved in the conserved in the deformation topology.
Hawking Radiation causes evaporation.	**720-degree embedding topology prevents the separation of virtual pairs at the boundary. Hawking radiation does not exist.**

Figure 11: Myth vs. Substrate Reality. Standard GR assumptions of infinite density, information loss, and Hawking radiation are contrasted with a finite-core BFUT structure, information conservation in continuous substrate, and the BFUT claim that Hawking radiation does not arise from its compact-object mechanism. [17, 18]

13. Nine Popular Myths About Singularities: Scientific Assessment

Singularities occupy an unusual position in physics: they are both mathematically derived from well-tested equations and physically unobserved. This has produced a body of popular understanding that conflates mathematical results with physical facts, and extrapolates from GR into domains where the substrate physics of the Spaticle field shows GR's premises do not apply. The following nine claims are assessed systematically.

13.1 Myth: Singularities Are Physically Real, Confirmed Objects

No singularity has ever been directly observed. What have been observed are: the gravitational influence of compact objects (from stellar orbits, gravitational lensing, gravitational waves, and EHT imaging); and the shadows of compact objects, consistent with the four-region BFUT structure as well as with classical Schwarzschild or Kerr solutions at large distance. Finite substrate relaxation additionally predicts a distinctive post-merger gravitational-wave signature for future observations. None of these observations require a singularity. All are explained by the BFUT finite-core structure. The singularity is a mathematical prediction of GR applied to a medium-free geometry. It is not an observed physical entity. The distinction between "the equations permit singularities" and "singularities exist" is categorical and must be maintained.

13.2 Myth: The Penrose-Hawking Singularity Theorems Prove Singularities Must Exist in Nature [17, 18]

The Penrose-Hawking singularity theorems [13] are rigorous mathematical results within the framework of GR. They establish that if the stated GR energy-condition assumptions and trapped-surface conditions hold, geodesic incompleteness follows within that framework. In BFUT, the extreme-compression regime is governed by the substrate restoring stresses generated by T4 and the higher-order T3 contribution $C|\psi|^6$. These terms produce the restoring response that opposes unlimited inward amplification and therefore move the physical system outside the NEC-restricted collapse regime assumed by the theorem. The same substrate restoring physics governs the condensation dynamics of P16 and the gravitational-response dynamics developed in P18. Thus the BFUT anti-singularity mechanism is a physical departure from the assumptions under which the GR singularity result is obtained. [17, 18]

13.3 Myth: Singularities and Black Holes Are the Same Thing

In classical GR solutions, a black hole is characterised by a causal event horizon; a curvature singularity can occur in the idealised interior solution but is not the definition of a black hole itself. In the BFUT framework, the event-horizon interior structure and singularity are replaced by a finite vortical compression core with a permeable coherence boundary. At large distances, the BFUT compact structure reproduces the corresponding classical external gravitational behaviour, while differing categorically in its interior. Conflating the singularity with the black-hole object leads to the mistaken conclusion that eliminating singularities eliminates the observed compact objects. It does not. The compact objects observed by EHT, LIGO, and stellar-orbit tracking remain physical systems; BFUT supplies a different interior description.

13.4 Myth: Singularities Are Infinitely Small - Zero-Dimensional Points

The mathematical singularity in GR is a limit, not an object with a defined size. In BFUT that limit does not arise. The compressed core has a finite local coherence scale. At equilibrium $L_{rlx} \approx 45.17$ AU, while the local coherence scale in a compact object is expected to be smaller because the substrate state is denser. These are different densities and different length scales and should not be identified with one another.

13.5 Myth: The Big Bang Was a Singularity

13.6 Myth: Singularities Mean Information Is Permanently Destroyed

The information paradox arises only if two conditions are simultaneously met: a true one-way event horizon (so information cannot exit) and a genuine singularity (so information is destroyed inside). The BFUT framework eliminates both conditions. The coherence boundary is permeable ($\eta > 0$ inside, no observer is causally trapped). The interior is a physically active compressed substrate state that continuously encodes infalling matter in organised deformation patterns. Carrier relaxation emission propagating outward through the coherence boundary on the transient carrier-response timescale τ_c carries encoded information as structured substrate disturbances [P18]. Information is not destroyed. It is distributed - encoded in the substrate state of the core and progressively released. This is not a conjecture or a quantum correction to an otherwise paradoxical theory: it is a direct consequence of the substrate being a continuous elastic medium with no discontinuities and no regions where physical evolution ceases.

13.7 Myth: White Holes Are the "Exit" of Singularities

White holes are a mathematical consequence of extending the Kruskal-Szekeres maximally extended Schwarzschild spacetime to include both the future and past singularities and both the exterior and interior regions of the full analytic extension. They represent a time-reversal of the black hole - a region from which matter can only emerge, not enter. No white hole has ever been observed. In the BFUT framework, white holes do not arise because the premises of the Kruskal-Szekeres extension - a true singularity, a true event horizon, and the full maximally extended spacetime - are all replaced by the substrate physics. The finite-core structure has no time-reversal anomaly requiring a white hole counterpart: matter enters the outer entrainment region, crosses the permeable coherence boundary, and contributes to the organised compression state of the core. The time-reverse of this process is carrier relaxation emission - not a separate class of object.

13.8 Myth: Naked Singularities Would Destroy Physics - Cosmic Censorship Must Hold

Penrose's cosmic censorship conjecture proposes that singularities formed in realistic gravitational collapse are always hidden behind event horizons - never "naked" and visible to external observers. The conjecture has never been proven in full generality and is violated in certain numerical simulations [13]. In the BFUT framework, the cosmic censorship question has no physical role to resolve. Neither naked singularities nor hidden singularities exist in the BFUT universe. The question of whether a singularity is censored is moot when singularities do not form. The coherence boundary plays the role of a physical boundary between organised compression and standard gravitational domain dynamics - but it is not a causal absolute and it does not need to protect the exterior from a singularity that does not exist. [17, 18]

13.9 Myth: Singularities Prove That Space and Time Break Down - Physics Has Limits

The conclusion that singularities show "physics breaks down" confuses the breakdown of a particular model description with the limits of physical reality. In BFUT, GR without an explicit physical carrier medium, substrate restoring dynamics, and finite-domain persistence is recovered as the zero-substrate-density limit of the Spaticle framework: the restoring mechanisms and finite-domain effects vanish, and the GR equations permit singularities. At the physical non-zero substrate density $\rho_s = 7.3 \times 10^{-27}$ kg/m³, the BFUT substrate dynamics prevent singularities. Within the BFUT framework, the mathematical singularity therefore marks the limit of the medium-free approximation; physical reality does not break down.

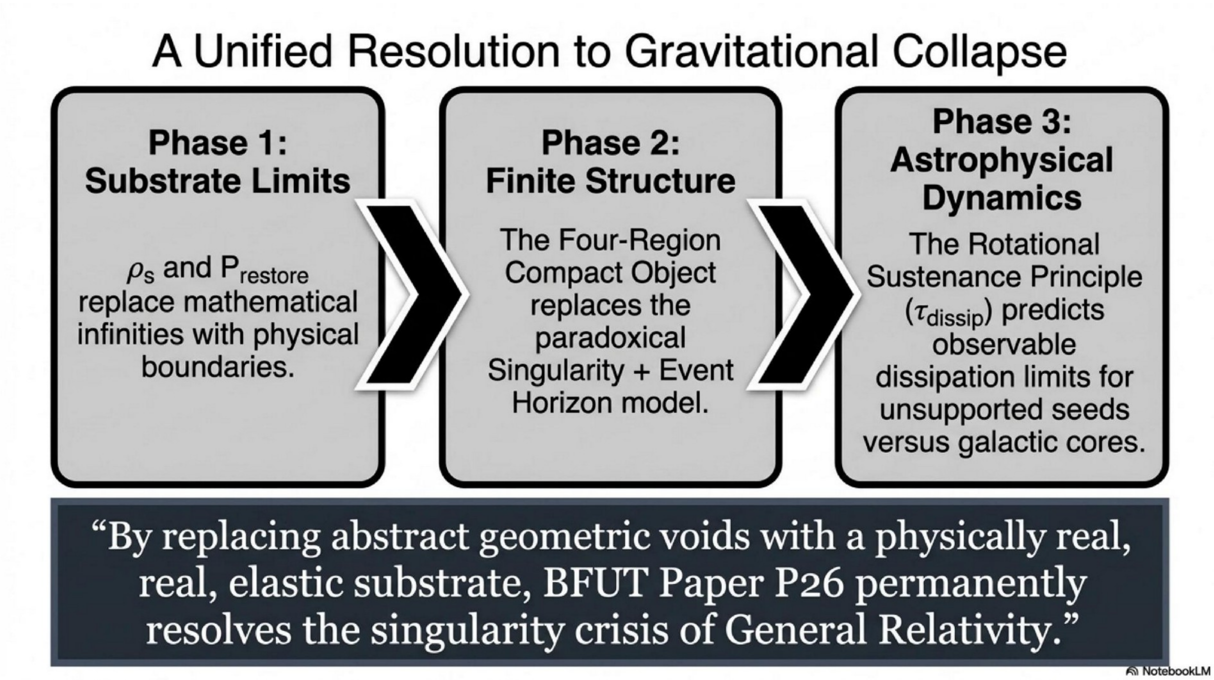


Figure 12: A unified resolution to gravitational collapse. Substrate limits (Phase 1) produce finite structures (Phase 2) whose persistence depends on rotational sustenance (Phase 3).

14. Falsifiable Predictions

Prediction	Observational Test	BFUT Basis
P1: Finite vortex core in stellar-mass compact objects.	Very-long-baseline interferometry observations of compact-object shadows should reveal finite-core structure with a finite core structure whose macroscopic scale can be tested once the local coherence-to-macroscopic mapping is established, rather than an unresolved structure corresponding to the singular interior of the idealised GR solution.	§9.7; L_rlx = c τ_nat at equilibrium
P2: Enhancement fraction saturation at 14-20% for	Measure DDR enhancement fractions for a sample of clusters of varying mass and richness;	§11; §7

large massive galaxy clusters. Particulate dark matter halos would produce no saturation.	saturation pattern is the key discriminant.	
P3: Differential enhancement floor between cluster-embedded and field galaxies. Cluster-embedded galaxies should show slightly higher enhancement floors than matched isolated field galaxies.	Compare enhancement floors for mass-matched galaxies in and out of rich clusters; differential is a direct prediction of nested-domain reinforcement.	§8; §11
P4: Pathway 2 and 3 seed cores in environments below the Rotational Sustenance Threshold - isolated field supernovae in sparse environments - do not produce persistent compact objects.	Compare compact object persistence rates in sparse vs. dense stellar environments; persistent compact objects should correlate strongly with environments exceeding the RST.	§10.2; §10.3

15. Conclusion

Singularities arise in GR because curvature is treated geometrically without a physically organised carrier medium possessing redistribution, persistence, and restoring dynamics. Once curvature is treated as organised deformation within the Spaticle field, five simultaneous stabilising mechanisms emerge: substrate restoring response from T4, higher-order compression resistance from $C|\psi|^6$, outward redistribution from rotational entrainment, finite-core vortex stabilisation at ℓ_c, and coherence threshold destabilisation of sustained inward amplification. The current P16 condensation functional independently excludes zero-radius point collapse without introducing a new free parameter.

The Rotational Sustenance Principle, introduced in this paper, establishes that no vortical compression core of any origin can persist without surrounding rotating mass. Pathway 2 and Pathway 3 cores do not persist without rotational reinforcement. They are not merely less stable. Pathway 1 cores are inherently permanent because the formation mechanism and the sustenance mechanism are identical. The Rotational Sustenance Threshold defines the quantitative condition separating persistent from dissipating seeds.

The temporal anti-singularity proof (P22 connection) and the dynamical proof (five restoring mechanisms) apply simultaneously and reinforce each other. The Penrose-Hawking singularity theorems [13] do not govern the BFUT extreme-compression regime because the substrate restoring stresses move the system outside the NEC-restricted collapse assumptions of the GR theorem. Nine popular myths about singularities are addressed; in each case the myth is shown to follow from applying GR premises to the physical universe without the substrate, and to dissolve once the Spaticle substrate is taken into account. [17, 18]

Black holes, as conventionally understood, do not exist as independent self-contained objects with singular interiors. What are observed as black holes are finite vortical compression cores sustained by galactic rotational dynamics within the Spaticle field - analogous to whirlpools in a compressible medium, under the conditions stated: Spaticle field as medium, three-dimensional volumetric immersion, and infinite space with no natural friction. The information paradox does not arise. The cosmic censorship question is dissolved. The breakdown-of-physics interpretation is shown to be a category error. Physical reality does not break down at extreme compression. The approximation does.

Appendix A: Symbol Reference

Symbol	Definition	Value / Expression
ρ_s	Intrinsic equilibrium density of the Spaticle field	7.3×10^{-27} kg/m³
Ψ_vac	Vacuum equilibrium state of Spaticle field	
τ_c	Transient carrier-response time	Response timescale; local and

	used for F1-cov relaxation dynamics	dynamical
τ_{nat}	Equilibrium substrate relaxation time	$L_{nat}/c \approx 6.26$ h
L_{rlx}	Substrate relaxation length; e-folding length for unsustained equilibrium disturbances	$c \times \tau_{nat} \approx 45.17$ AU at equilibrium
ℓ_c	Local coherence length; finite core radius scale	$c\tau_{local}$; decreases with increasing density
R_d	Intrinsic deformation-domain radius	$(3M/8\pi\rho_s)^{(1/3)}$
R_{eff}	Rotationally enlarged effective domain radius	$R_d \times (1 + v_{rot}^2/c^2)^{(1/3)}$
C	Coherence parameter	$v_{rot} \times r/(\nu_{eff} L)$
C_{crit}	Coherence threshold for organised compression	Derived from free-energy functional
RST	Rotational Sustenance Threshold	$C > C_{crit}$ maintained by surrounding rotating mass; see §10.4
η	Local propagation efficiency	c_s/c_0; > 0 everywhere; $\eta = 0$ operationally unreachable (P22)
η_{enh}	DDR enhancement fraction	v_s/v_{obs}; bounded above at 0.60; floor at 0.14-0.20
$J_{entrain}$	Outward entrainment flux from core	Proportional to $v_{rot} \times \rho_{local}$; saturates at C_{crit}
T1-T5	Terms of Spaticle field free-energy functional	Gradient, kinetic, potential, vacuum stabilisation, thermal - see P16
NEC	Null energy condition	Required by the Penrose-Hawking theorem assumptions; the BFUT restoring stress departs from the NEC-restricted collapse regime at extreme compression

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