

RELATIVITY OF MATTER

THE MISSING STATE OF THE UNIVERSE

Pillar I / Book I - The Genesis of RM

FROM THE TROJAN HORSE
TO THE PHOTONIC STEP

A GEOMETRY WITH ITS OWN CONSTITUTIVE LENGTH

“A theory earns the right to be defended only after it has been given a fair chance to destroy itself.”

PIERRE BENAROS

Independent Researcher • 2026

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BOOK I

A Note to the Reader

This edition is written after a reversal that changed the meaning of the entire book. The older edition devoted its centre of gravity to a failed nuclear construction. That failure remains historically true, but it is no longer the destination. It became the door through which the constructive branch entered.

STATUS - v5.3.0 - concordance repaired; the audit trail remains append-only

Version 5.3.0 preserves the numerical and transport results of v5.2.0 and receives three later clarifications without rewriting their history. First, the homogeneous bulk note now retains HBR-1 as the exact reduced $U = 0$ theorem while adding a conditional thermal-radiative extension. Second, the active stellar interpretation assigns primary constitutive loading to the thermal-radiative sector; redshift remains a genuine propagation observable and a possible secondary energetic contribution whose sign and share are not fixed. Third, the off-center mechanical audit separates matched birth, newborn storage and full formation cost, preventing the unit boundary benchmark from being misread as a complete cosmic conversion law.

There is an awkward advantage to independent research: there is no committee available to blame when an equation fails. The same person chooses the postulate, writes the derivation, reads the criticism, repairs the typography and signs the claim. A reader may reasonably grant an independent author some indulgence for editorial roughness. No indulgence is requested for the algebra. An equation is either reproducible in its stated domain or it is not.

PRINCIPLE - Reproducibility before provenance

A result enters RM only through an explicit derivation, a reproducible numerical calculation, or an announced postulate. Every imported assumption must be named, every division must be reversible on the branch where it is used, and every numerical claim must state the problem that was actually solved. The scientific responsibility for the selections and claims remains Pierre Benaros's.

RESULT - Cross-method status of the stellar numerics

The regular undivided $Q_c < 0$ solution is reproduced by two numerically distinct post-v28 implementations. At the declared test pressure, DOP853 shooting and two-domain collocation agree on the global radius and mass to the displayed precision and both recover a smooth internal $Q = 0$ crossing. The existence and regularity of this branch are therefore cross-method results of the present computational corpus. The dated v28 coordinates remain in the audit record as the historical discovery path. No external human numerical reproduction is claimed in this edition.

This book therefore does not ask the reader to believe RM. It asks for something both less comfortable and more useful: read the chain, identify the point at which it fails, and try to reproduce that failure.

The 90-Second Case

If this is the only page you read, read it as a map of the claim - not as a substitute for the derivations.

1. RM first tried to make State $\mathcal{A}$ the local material of nuclear cohesion. The branch failed. The failure was not hidden and was not repaired with a fitted coefficient.
2. The failure forced a separation of prerogatives: matter keeps its internal cohesion and energy; State $\mathcal{A}$ carries relational response, transmission and cadence. The discarded branch became the methodological “Trojan Horse” of the programme.
3. The constructive line N-EMPR then found a matter imprint on the relational field, an exact integrated cadence identity, and finally a closed hydrostatic system. In v26 the RM equations recover the standard Tolman-Oppenheimer-Volkoff equations exactly when the RM sectors are switched off - with no new fitting coefficient.
4. The same action already contains a geometric scale before any stellar EOS is chosen: $X_{\mathcal{R}} = \ell_{\star}^4(a^2 + 2b^2)$. When the local curvature length approaches $\ell_{\star}$, the nonlinear constitutive response is no longer perturbative. Book I v4.1.0 names that built-in geometric feedback the **Exclusion Interaction**; no new coupling is added.
5. With one toy equation of state announced before calculation, the standard TOV control sequence displays its mass turning point. The RM sequence remains increasing through the v27 window and becomes markedly more compact.
6. Returning in v28 to the undivided Euler-Lagrange equation removes an artificial singularity created by division by Q . At the same central pressure $p_c = 0.5028$, two converged hydrostatic solutions appear on opposite sides of the Q fold.
7. Reparameterising the upper family by X_c reveals a local extremum of central energy near

$$X_{c,\star} = 0.905249, \quad \varepsilon_{c,\star} = 1.212032$$

while an independently derived homogeneous calculation from v24.1 gives

$$X_{\text{sat}}^{\text{bulk}} = 0.90525591, \quad \varepsilon_{\text{sat}}^{\text{bulk}} = 1.21203543.$$

The numerical proximity is not imposed and is not promoted here into an identity.

8. CA-1 supplies the cross-method confirmation of the upper stellar branch. At $p_c = 0.5028$, DOP853 shooting gives $R = 2.08849775$, $M = 0.84685706$, while a separately implemented two-domain collocation gives $R = 2.08849761$, $M = 0.84685714$. Both display the same regular $Q_c < 0$ state and a smooth internal $Q = 0$ crossing. The earlier v28 value $R = 2.046754$, $M = 0.850506$ is retained as the dated numerical record that led to the branch; the active branch-existence claim rests on the cross-method reproduction.
9. N-OPT-01 v34.1 then turns the cadence idea into a first-passage equation. If the material random walk has local Fick generator $\mathcal{L}_{\text{loc}} = \nabla_i(D_{\text{loc}}\nabla^i \cdot)$ and $d\tau_{\text{cad}} = N dT$, the mean universal escape time satisfies

$$\mathcal{L}_{\text{loc}}\Theta = -\frac{1}{N}.$$

On a frozen background $\{g_{ij}, D_{\text{loc}}\}$, the cadence contribution is exactly a positive weighted mean of $1/N$. The optical index remains an optical quantity; it is no longer misidentified with cadence.

10. The post-v28 global branch separates boundary production from interior dilation exactly:

$$\dot{V}_{\mathcal{E}} = \int_{\Omega} \Theta_{\mathcal{E}} dV + \Gamma_{\partial}.$$

A domain can therefore grow by its boundary without automatically reproducing the observed interior recession of galaxies.

11. The later homogeneous-bulk audit derives the reduced bulk rate without importing a Friedmann law. With $B(e) = 2\varepsilon_z + 3\varepsilon'_z$, the Version-5 theorem is

$$H [3B'(e) + 3\rho_m + 8u_\gamma] = s,$$

and is retained in the current bulk paper as the exact $U = 0$ branch.

12. The active thermal completion keeps $u_\gamma = a_R \Theta^4$, replaces the stellar source reading by a thermal constitutive reservoir $\varepsilon_{\mathcal{E}}^{\text{th}}$, and adds the curvature-Exclusion sector $U(X)$. Constraint preservation then gives the conditional extension

$$H [3B'_{\text{th}} + 8XU' + 16X^2U'' + 3\rho_m + 8u_\gamma] = s.$$

For $U = 0$ it returns exactly to HBR–1.

13. The Maria construction supplies a conditional upper thermal load under UC–1. The further statement that approach to that limit closes the radiative channel and selects $EM \rightarrow \mathcal{E}$ is a working bridge, not a derived microscopic conversion law. Redshift is not deleted: it remains a physical propagation observable and may contribute secondarily, but no numerical partition is inserted by hand.
14. At the cosmic boundary, the ideal absorbed-flux benchmark still uses $\mathcal{U}_{\partial}\Gamma_{\partial} = \mathcal{P}_{\gamma,\partial}$. The natural scale $P/\ell_\star^2$ is available dimensionally, but the unit identification $\mathcal{U}_{\partial} = P/\ell_\star^2$ is a conditional constitutive branch, not a derived residual density of newborn volume. Full formation cost also contains layer storage, outgoing products and exchanged work when those sectors are present.

RESULT - What has actually been discovered

Book I now carries three especially clean internal results. First, the undivided stellar system contains a regular $Q_c < 0$ hydrostatic solution reproduced by both DOP853 shooting and two-domain collocation. Second, N-OPT-01 v34.1 shows that a local material random walk translated to universal time obeys the Dynkin cost law $\mathcal{L}_{\text{loc}}\Theta = -1/N$, giving an exact positive weighted-cadence theorem on a frozen background. Third, the homogeneous bulk audit derives HBR–1 from the surviving zero-mode constraints and retains it as the exact reduced $U = 0$ branch; the later thermal equations extend rather than erase that theorem. The unit boundary-cost identification and the Maria-to- $EM \rightarrow \mathcal{E}$ transition remain conditional constructions with their status stated explicitly.

PRINCIPLE - Discovery and measurement are different levels of claim

An internal mathematical or numerical discovery is stated as such, without apology and without inflation. Empirical confrontation answers a different question: whether Nature realises the

discovered RM structure. The distinction protects the discovery from both understatement and overstatement.

Epistemic Contract of v5.3.0

Label	Meaning in this book
Postulate	An ontological or constitutive input of RM. It is not converted into a theorem by repetition.
Derived result	A consequence of an explicit action, identity or algebraic chain under stated assumptions.
Conditional numerical result	A converged result for a specified EOS, parameter set, boundary-value problem and branch.
Scope boundary	A statement that belongs to another Pillar, another physical regime or an external experiment. It is not presented as unfinished prose inside Book I.

This change of vocabulary is deliberate. The old Book I repeatedly displayed “open programme” boxes. They were honest in 2026, but they made the volume read like a construction site. The present edition is complete in its own function: it records the epistemological genesis, the non-repair rule, the separation of physical roles, and the unexpected constructive consequence that followed. Technical authority remains with Pillar II and the dedicated N-EMPR notes; constitutional authority remains with Pillar IV.

Contents

PART I - THE EPISTEMOLOGICAL PURGE	6
01 – When the Map Replaces the Territory	7
02 – Time and Dimensions: Two Famous Promotions	7
03 – Singularities Are Questions, Not Objects	8
PART II - THE GRAMMAR OF RM	9
04 – State $\mathcal{A}$ and Silentium	10
05 – Matter Keeps What Belongs to Matter	11
06 – Cadence Becomes an Equation	11
07 – The Rule That Saved the Programme	12
PART III - THE TROJAN HORSE - ONE SCAR	13
08 – The Hypothesis That Was Allowed to Die	14
09 – The Failure Changes Sign	14
PART IV - THE CONSTRUCTIVE ASCENT	16
10 – Pressure Enters Without a New Knob	17
11 – The Standard TOV Test	17
12 – The Constitutive Length of Space	18
13 – The First Mass-Radius Sequence	20
PART V - THE STELLAR FOLD	22
14 – Do Not Divide Away a Branch	23
15 – Two Stars at the Same Central Pressure	23
16 – The Fold Was Already Waiting	24
17 – Extreme Compactness and Cross-Method Confirmation	26
PART VI - THE COSMIC BOUNDARY	28
18 – The Border Is Not the Interior	29
19 – Radiation Reaches a Moving Boundary	30
20 – The Price of New Volume	31
21 – Three Ledgers, No Hidden Equivalence	32
22 – The Bulk Closes; the Bridge Remains Open	33
PART VII - THE PHOTONIC STEP	35
23 – The Step Has Three Owners	36
24 – Dynkin Puts N on the Right Side	37
25 – The Photonic Step Becomes an Equation	38
Current Status Register	42
Falsification Triggers Carried Forward	44

Reproducibility Snapshot and Source Hierarchy

46

PART I

THE EPISTEMOLOGICAL PURGE

Stop notation from inventing the Universe.



01

When the Map Replaces the Territory

Calculation is not constitution

Mathematics is the most powerful instrument of intellectual compression ever produced. Its danger begins only when a property of the notation is promoted, without an intermediate mechanism, into a property of the world.

A curve diverges: an infinite density is announced. A metric has four coordinates: a fourth physical substance is announced. A ledger does not close: an invisible component is added. None of those moves is automatically false; none is automatically physical either. The missing step is always the same: what in reality pays the physical bill of the construction?

RM begins with a refusal of automatic ontology. An equation may guide, reveal, condense and predict. It does not receive the power to manufacture a dimension, a singular material point, a substance, a pressure or a mechanism merely because the formal continuation permits it.

PRINCIPLE - Rule of priority

Whenever a mathematical extension and a physical requirement conflict, the extension must be reinterpreted, bounded or abandoned. Reality is never declared at fault because it refuses to continue a formula.

This rule is not anti-mathematical. It is aggressively pro-mathematical: it asks the mathematics to expose its domain of validity instead of concealing it behind eloquence.

02

Time and Dimensions: Two Famous Promotions

A coordinate is not a substance; a cadence is not time

Two of the most successful representational tools in physics are also two of the easiest to reify: spacetime coordinates and clock readings.

A state may require many variables without the world acquiring the same number of physical directions. A symmetric relational state tensor q_{ij} in three-dimensional space already carries six independent components,

$$q_{ij} = q_{ji} \implies 6 \text{ independent components,}$$

without opening six additional directions of space.

The same discipline is applied to clocks. A clock counts repetitions of a physical process. RM therefore separates universal ordering from local cadence:

$$T : \text{open universal line,} \quad \nu = \nu(\text{state, motion, gradient, interaction}).$$

The statement is not that measured clock differences are unreal. They are among the most precise facts in physics. The RM claim is that the minimal ontology is a difference in the physical cadence of processes, not an elastic temporal substance.

CONSTITUTIONAL READING - Current constitutional reading

Cosmological time is universal and open; only local physical cadence varies. Pillar IV fixes this as a normative RM input. Pillar II carries the technical cadence derivations.

The old Book I called the missing quantitative cadence law a future programme. That sentence is obsolete as a description of the present corpus. N-EMPR and Pillar II now contain explicit cadence identities. Book I no longer needs to promise them; it only needs to explain why the distinction mattered.

03

Singularities Are Questions, Not Objects

Zero volume, Black Core and the discipline of limits

Running a successful equation backwards until it reaches a singular value does not prove that Nature contains the singular value. It proves that the representation has reached a question.

RM rejects the conversion of zero volume and realised infinity into physical objects. This is a methodological statement before it is a model of compact objects. A physically admissible compression must therefore encounter a regime change, a transition, a loss of branch, a new state or a constitutive limit before an accomplished singular material state is reached. The ideal singular point is excluded as a physical endpoint by the RM domain of admissibility.

The current RM strong-field language is therefore a finite constitutive-exclusion architecture, not the older language of an infinitely compressed centre. Pillar I does not pretend to replace the technical strong-field calculations of Pillar II; it fixes the prohibition that any such calculation must obey: no singularity is promoted to ontology merely because a denominator reaches zero.

This principle will return unexpectedly in v28. There the numerical difficulty near $Q = 0$ initially looked like a physical wall. The wall disappeared when the equation was written without dividing by Q . The lesson is almost embarrassingly literal: before announcing a singularity of Nature, check whether you created it with algebra.

PART II

THE GRAMMAR OF RM

Matter, radiation, State $\mathcal{A}$, maximal cohesion - and one universal time line



04

State $\mathcal{A}$ and Silentium

Do not confuse the continuum with its ideal outside

RM names State $\mathcal{A}$ as the physical relational continuum of the manifested domain. Silentium is reserved for the ideal limit external to that manifested domain. The two words are not synonyms.

The current ontology distinguishes four physical states or sectors used throughout the corpus: matter m , electromagnetic radiation, State $\mathcal{A}$, and E , the state of maximal cohesion. Silentium is not a fifth physical substance. It marks the ideal external limit at which the laws carried by the manifested continuum are not assumed to continue as if nothing had changed.

This distinction matters particularly in cosmology and stellar physics. The active architecture no longer assigns one universal energetic role to redshift. It keeps three objects separate: thermal-radiative constitutive loading in the stellar application, redshift as a propagation observable with a possible but unquantified secondary energetic contribution, and boundary production associated with extension of the manifested $\mathcal{A}$ domain.

For explanatory diagrams, Book I therefore uses the following safety notation:

$\varepsilon_{\mathcal{A}}^{\text{th}}$: thermal constitutive reservoir in the stellar application

Γ_{∂} : boundary-production channel

The symbol ε_z is retained only where a specific historical or global-elastic reservoir has been explicitly defined. It is not a universal “redshift fuel” and it must never be converted into $\varepsilon_{\mathcal{A}}^{\text{th}}$ by a change of label. Redshift itself remains physical; what has been withdrawn is the claim that accumulated redshift energy is the primary source of stellar constitutive support.

PRINCIPLE - Notation as a safety device

If two quantities play different physical roles, their symbols must make that difference visible. A notation that allows a source to become a stock halfway through a derivation is an invitation to circular reasoning.

05

Matter Keeps What Belongs to Matter

The constitutional separation of prerogatives

The most important sentence produced by the failed nuclear branch was not an equation. It was a boundary: State $\mathcal{A}$ must not be asked to fabricate what belongs to matter.

MATTER m	STATE $\mathcal{A}$
Nuclear cohesion and internal structure	Transmission and relational organisation
Internal energy E_0	Gradients and constitutive response of the continuum
Material charges and material transitions	Propagation and modulation of physical cadence
Selection of the material configuration	Relational imprint and macroscopic response

The separation born from the Trojan Horse and retained by the current Constitution.

The current nuclear working sentence is deliberately narrower than the rejected one: State $\mathcal{A}$ may condition a passage or transition without becoming the strong interaction or the internal cement of matter. The slogan used in the research notes is: “ $\mathcal{A}$ opens the nuclear passage; the Exclusion Interaction limits the throughput.” In Book I that sentence is a directional hypothesis, not a completed microscopic derivation.

The gain is epistemological as much as physical. An omnipotent continuum would explain everything and therefore almost nothing. A continuum with forbidden prerogatives can fail.

06

Cadence Becomes an Equation

From the imprint of matter to an exact integrated identity

The old manifesto distinguished time from cadence philosophically. The N-EMPR line made the distinction calculable.

In the static spherical branch, the inherited variables are

$$a \equiv \frac{f'}{r}, \quad b \equiv \frac{1-f}{r^2} - \frac{a}{2}, \quad X_{\mathcal{R}} = \ell_{\star}^4(a^2 + 2b^2),$$

with

$$G \equiv u_{\star} \ell_{\star}^4 F'(X_{\mathcal{R}}), \quad Q \equiv PZ + G(a - b),$$

$$Z(\chi) = \chi^4, \quad W(\chi) = \kappa_W \chi^2 (1 - \chi)^2, \quad F(X) = 1 - \sqrt{1 - X} - \frac{X}{2}.$$

The v24.2 cadence equation could be regrouped in v25 into the exact identity

$$\frac{d}{dr} \ln \left(\frac{NQ}{\sqrt{f}} \right) = \mathcal{S}(r)$$

and therefore, with the asymptotic normalization $N \rightarrow 1$, $f \rightarrow 1$, $Q \rightarrow P$,

$$N(r) = \frac{P\sqrt{f(r)}}{Q(r)} \exp \left[- \int_r^\infty \mathcal{S}(s) ds \right].$$

This is the conceptual reversal of the old chapter on “elastic time”. The lapse/cadence observable is not introduced as a deformation of time. It is transported by a physical field equation whose ingredients can be audited.

RESULT - Why v25 matters inside Book I

The philosophical sentence “clocks count cadence, not time” acquired a concrete static identity. Book I can now tell the origin of the distinction without ending on a promise to calculate it later.

07

The Rule That Saved the Programme

Non-repair, falsifiability and the right to be wrong

A theory becomes difficult to kill the moment its author begins to love it. RM therefore constitutionalised an asymmetric rule: a failed branch may be removed, but it may not be rescued after the fact by a coefficient chosen from the desired answer.

The non-repair rule is not ascetic theatre. It protects the meaning of every later success. If a parameter is added after a failure only because it restores the expected number, the calculation may fit but the mechanism has stopped explaining.

The same rule applies to numerical work. A solver failure is not automatically a physical boundary; a converged solution is not automatically stable; a beautiful extrapolation is not a result. The right sequence is:

derive $\rightarrow$ solve $\rightarrow$ try to break $\rightarrow$ state only what survived.

That discipline is why the old failure remains in this edition at all. It is not a monument to defeat. It is the certificate that the later branch was not allowed to inherit a hidden rescue term.

PART III

THE TROJAN HORSE - ONE SCAR

The old Book I spent six chapters here. This edition needs one.



08

The Hypothesis That Was Allowed to Die

From nuclear cement to a forbidden rescue

The historical branch asked State $\mathcal{A}$ to become the local material of nuclear cohesion. It almost worked often enough to become dangerous.

The sequence passed through local elastic wells, a non-local plateau, a shell, topological hopes and finally a bag-pressure junction. At several stages a number appeared that looked like victory. The plateau could reproduce the required hierarchy if an unselected product such as mL took the correct value. The shell could be written, but its scalar topological charge vanished. Derrick scaling drove contraction without a legitimate stabilising volume term. Bag pressure seemed capable of restoring the target, but only by importing the very hierarchy the calculation claimed to derive.

The precise historical details remain in archived N-ELAST and N-JONC notes. They are deliberately not replayed here page after page. The single fact needed by the current Book I is this:

FALSIFICATION / LIMIT - The Trojan Horse verdict

The attractive nuclear-droplet branch was rejected in its audited class. No coefficient was promoted to a law of Nature to save it. The rejection remains part of the audit trail and is not silently rewritten by later successes.

The irony is that this was the branch once expected to prove the programme. Instead it proved the discipline of the programme. It forced the separation “matter is matter; $\mathcal{A}$ is $\mathcal{A}$ ”, which became the starting condition for the constructive line that followed.

“The failure did not tell us that $\mathcal{A}$ was useless. It told us what $\mathcal{A}$ was forbidden to pretend to be.”

09

The Failure Changes Sign

Matter imprints the continuum instead of being manufactured by it

Once matter was no longer required to emerge from the relational field, the direction of the calculation could be reversed: start with matter as matter and ask what imprint it leaves on State $\mathcal{A}$.

N-EMPR-01 established, in the audited local class, the sign of that imprint: material loading drives the scalar relational variable onto the $\chi \geq 1$ side rather than toward the discarded $\chi \rightarrow 0$ nuclear phase. The old attempt had tried to make the continuum collapse into matter. The new branch let matter deform the continuum while keeping the two ontologies distinct.

That reversal is the real bridge from the Trojan Horse to the technical ascent:

$$\boxed{\varepsilon_m \longrightarrow \chi \longrightarrow Z(\chi) \longrightarrow Q \longrightarrow N \longrightarrow \text{observable cadence.}}$$

The old failure chapter therefore survives only as a scar because its constructive consequence is now more important than its anatomy.

PART IV

THE CONSTRUCTIVE ASCENT

v25, v26 and v27: when the manifesto becomes a stellar system



10

Pressure Enters Without a New Knob

The v26 hydrostatic closure

The decisive question was simple to state and hard to fake: can pressure be added from the same matter interface without inventing an RM-specific pressure coefficient?

For the minimal matter interface, spatial relabelling gives the exact hydrostatic identity for a static perfect fluid,

$$p' = -(\varepsilon + p) \frac{N'}{N}.$$

The radial metric variation contributes exactly the pressure term needed to replace the dust source by $\varepsilon + p$ in the cadence equation. The resulting TOV-RM sector is

$$\frac{N'}{N} = \frac{f'}{2f} + \frac{r(\varepsilon + p)}{4fQ} + \frac{r\kappa_\chi \chi'^2}{4Q} - \frac{Q'}{Q} - \frac{G(a+b)}{rQ}$$

and therefore

$$p' = -(\varepsilon + p) \left[\frac{f'}{2f} + \frac{r(\varepsilon + p)}{4fQ} + \frac{r\kappa_\chi \chi'^2}{4Q} - \frac{Q'}{Q} - \frac{G(a+b)}{rQ} \right].$$

Together with the Hamiltonian constraint and the χ equation, an equation of state $\varepsilon = \varepsilon(p)$ closes the static spherical system in the variables $(\chi, \chi', f, \ln N, p)$.

RESULT - v26

Within the stated minimal matter interface, the hydrostatic RM system is structurally closed. Pressure is derived from the same action structure; no phenomenological TOV correction coefficient is inserted.

11

The Standard TOV Test

The calculation is required to forget RM correctly

A modified gravity equation is cheap if its standard limit is adjusted afterwards. v26 imposed the opposite test: switch the RM sectors off and demand the ordinary TOV equations exactly.

Set

$$Z = 1, \quad G = 0, \quad \chi' = 0, \quad Q = P.$$

With

$$P = \frac{c_{\mathbb{E}}^4}{16\pi G_N}$$

and the geometric mass defined by $f = 1 - 2m/r$, the constraint gives

$$m' = \frac{r^2 \varepsilon}{4P},$$

while the cadence equation becomes

$$\frac{N'}{N} = \frac{m + r^3 p / (4P)}{r^2 (1 - 2m/r)}$$

and hence

$$p' = -(\varepsilon + p) \frac{m + r^3 p / (4P)}{r^2 (1 - 2m/r)}.$$

These are exactly the standard TOV equations in the conventions of the action.

RESULT - Non-regression verdict

Standard TOV is recovered exactly, without an adjusted coefficient.

For a barotropic EOS, v26 also gives the exact enthalpy first integral

$$\mathcal{H}(p) = \int_0^p \frac{d\tilde{p}}{\varepsilon(\tilde{p}) + \tilde{p}}, \quad \mathcal{H}[p(r)] = \ln \frac{N(R)}{N(r)}.$$

This identity becomes a numerical lie detector: a mass-radius curve that violates it is not accepted because it looks attractive.

12

The Constitutive Length of Space

Why the strong-field RM regime is not merely a perturbation of GR

v28 was frozen before this interpretation was written. The next clue was already present in the action: RM gives its geometric sector a constitutive length, ℓ_* , before a stellar equation of state is supplied.

The invariant used throughout the N-EMPR strong-field branch is

$$X_{\mathcal{R}} = \ell_*^4 (a^2 + 2b^2), \quad a = \frac{f'}{r}, \quad b = \frac{1-f}{r^2} - \frac{a}{2}.$$

The point is not merely dimensional bookkeeping. If the characteristic local curvature scale is denoted

by $L_{\mathcal{R}}$, so that a and b are of order $L_{\mathcal{R}}^{-2}$, then schematically

$$X_{\mathcal{R}} = O\left[\left(\frac{\ell_{\star}}{L_{\mathcal{R}}}\right)^4\right].$$

Therefore

$$L_{\mathcal{R}} \gg \ell_{\star} \implies X_{\mathcal{R}} \ll 1,$$

while

$$L_{\mathcal{R}} \sim \ell_{\star} \implies X_{\mathcal{R}} = O(1).$$

In that second regime, the nonlinear RM sector is not a small perturbative decoration of a GR solution. It participates at leading order in the geometry being solved.

Classical Einstein-Hilbert GR	RM strong-field branch
With no cosmological constant or added higher-curvature sector, the Einstein-Hilbert action introduces no intrinsic local strong-field cutoff length analogous to $\ell_{\star}$.	$\ell_{\star}$ enters the geometric invariant $X_{\mathcal{R}}$ directly, before the stellar EOS is chosen.
Matter and boundary data determine the physical scale of a particular stellar solution.	Matter supplies the loading (ε, p) , but it does not choose the admissible constitutive domain $0 \leq X_{\mathcal{R}} < 1$.
A compactness theorem such as Buchdahl is a bound under stated assumptions, not an intrinsic length of the Einstein-Hilbert action.	The constitutive scale is action-level: when local curvature approaches $\ell_{\star}^{-2}$, the nonlinear response becomes order unity.

The comparison is action-level. It does not claim that the current reduced-unit calculation has already calibrated $\ell_{\star}$ in kilometres.

The Exclusion Interaction

The name **Exclusion Interaction** is the active interpretive label in this edition. It does not add a fifth force or a fitted coupling. It names the constitutive feedback already encoded by

$$F(X) = 1 - \sqrt{1 - X} - \frac{X}{2}, \quad F'(X) = \frac{1}{2\sqrt{1 - X}} - \frac{1}{2},$$

so that

$$X_{\mathcal{R}} \rightarrow 1^{-} \implies F'(X_{\mathcal{R}}) \rightarrow \infty.$$

The physical reading inside RM is that continued loading of the same geometric channel becomes increasingly difficult as the admissible constitutive limit is approached. Matter can load the geometry; it does not rewrite the geometric response law after the fact.

PRINCIPLE - The Exclusion Interaction

The matter loads; the geometry answers. As a regular RM configuration approaches its constitutive geometric limit, further compression through the same channel encounters an increasingly stiff response. The response may redirect the branch or require a separately defined state transition; it is not permitted to disappear by algebraic continuation through an inadmissible domain.

FALSIFICATION / LIMIT - Name, not analogy

“Exclusion” here has no connection to the Pauli exclusion principle. It denotes exclusion of an additional geometric deformation by the RM constitutive response. Nor does v4.1.0 claim that $\ell_\star$ has already been calibrated to a neutron-star radius. The v27/v28 sequence remains a reduced-unit, toy-EOS result.

This is the conceptual reason the high-density sequence is allowed to look qualitatively unlike its TOV control without any coefficient being retuned after the calculation. The EOS tells RM how matter responds. The action tells matter what geometric domain it inhabits.

13

The First Mass-Radius Sequence

The control curve turns; the RM curve does not

The first numerical test deliberately avoided a realistic neutron-star EOS. The purpose was more basic: prove that the same numerical machinery can produce a standard turning point and then ask what the RM equations do under the same declared test EOS.

The EOS was announced before calculation:

$$p = \rho^2, \quad \varepsilon = \rho + p$$

in reduced units. It is a validation EOS, not a claim about nuclear matter.

The standard TOV control sequence reaches

$$p_c = 0.101278, \quad \varepsilon_c = 0.419520, \quad M_{\max}^{\text{TOV}} = 0.894149, \quad R = 4.16964$$

with

$$\left(\frac{2M}{R}\right)_{\text{TOV,max}} = 0.428886.$$

The code therefore demonstrably knows how to display a turning point.

The RM continuation reaches in v27

$$p_c = 0.489, \quad \varepsilon_c = 1.18829, \quad M = 0.738409, \quad R = 2.28314,$$

$$\frac{2M}{R} = 0.646835, \quad X_{\max} = 0.817908,$$

with a still-positive last measured slope $\Delta M/\Delta \varepsilon_c \simeq 2.15$.

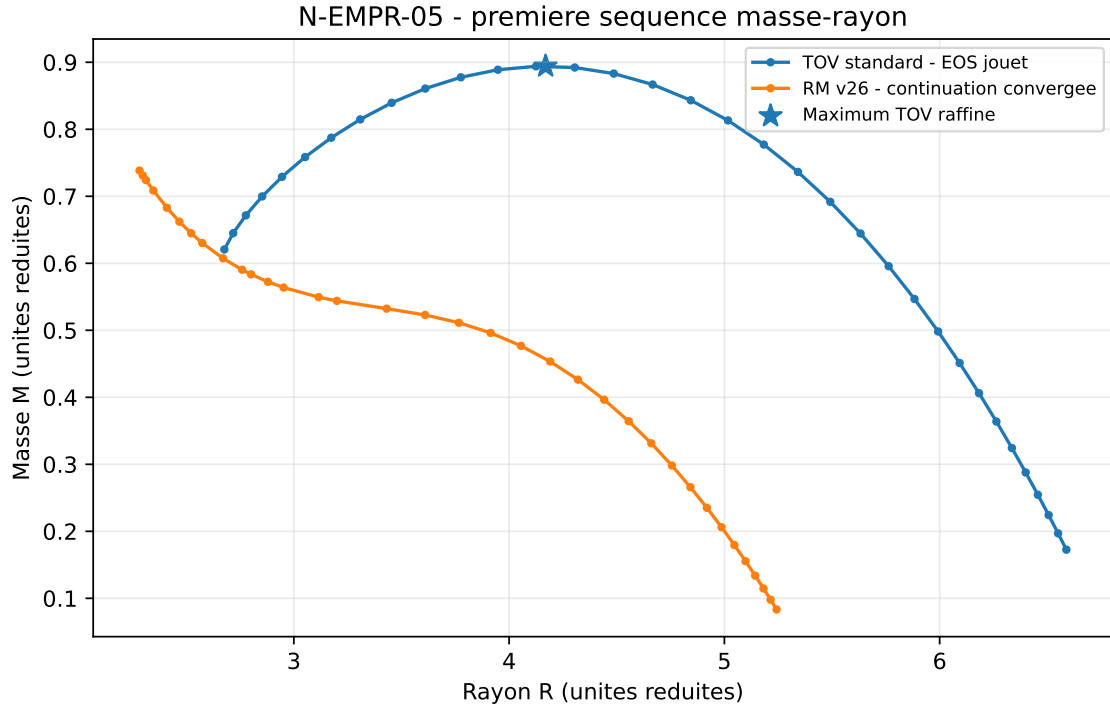


Figure 1: First mass-radius comparison in reduced units for the declared toy EOS. The figure is a solver-validation result, not an astrophysical mass-radius prediction in km or solar masses.

At identical $p_c = 0.489$, the standard control gives $C_{\text{TOV}} = 0.492514$ while RM gives $C_{\text{RM}} = 0.646835$, hence

$$\Delta C = 0.154321, \quad \frac{C_{\text{RM}}}{C_{\text{TOV}}} - 1 \simeq 31.3\%.$$

The increased compactness is mainly a contraction of radius, not an increase of mass.

FALSIFICATION / LIMIT - Scope of v27

The numbers are in reduced units and use a toy EOS. They establish a numerical behaviour of the stated equations. They are not solar masses, kilometres, a NICER fit, or an observed neutron-star prediction.

PART V

THE STELLAR FOLD

v28: the singularity that vanished when the division was undone



14

Do Not Divide Away a Branch

Why $Q = 0$ was an algebraic trap

The high-density continuation first appeared to terminate because the cadence equation had been written after division by Q . The correct response was not to declare a new wall of Nature. It was to return to the equation before the division.

The divided form contains $1/Q$ terms. The underlying radial Euler-Lagrange equation can instead be written schematically as

$$Q \frac{N'}{N} = Q \frac{f'}{2f} + \frac{r(\varepsilon + p)}{4f} + \frac{r\kappa_\chi \chi'^2}{4} - Q' - \frac{G(a+b)}{r}.$$

It remains algebraically defined at $Q = 0$ provided the full coupled system retains rank.

A second identity explains why the old solver became stiff. For the local Hamiltonian constraint $H = 0$ solved with respect to $a = f'/r$,

$$\frac{\partial H}{\partial a} = -2Q.$$

Thus $Q \rightarrow 0$ is exactly where a ceases to be a good algebraic variable. The failure of that parameterisation was real; the inferred end of the physical branch was not.

PRINCIPLE - The v28 lesson

A denominator may be a coordinate singularity of the calculation rather than a physical singularity of the model. The cure is to return to the undivided equation, not to replace zero by an arbitrary floor.

This is also why Book I rejects the proposed rule that every physical variable should be prevented numerically from reaching zero by replacing it with, for example, 10^{-100} . Such a rule would have erased the sign change of Q and therefore erased the second branch. The safer rule is symmetrical: *never introduce a zero artificially, and never forbid a physical zero artificially.*

15

Two Stars at the Same Central Pressure

The branch that the divided equation could not see

At $p_c = 0.5028$ the undivided split-domain BVP produces two distinct static solutions with the same central pressure.

On the $Q > 0$ side,

$$X_c = 0.899396, \quad Q_c = +0.051350, \quad M = 0.832632, \quad R = 2.112721, \quad \frac{2M}{R} = 0.788208.$$

On the $Q < 0$ side,

$$X_c = 0.910971, \quad Q_c = -0.059808, \quad M = 0.850506, \quad R = 2.046754, \quad \frac{2M}{R} = 0.831077.$$

The second solution closes the Hamiltonian constraint at approximately 1.3×10^{-8} in the reported split-domain solve, with the exterior mass stabilised.

RESULT - Structural result of v28

The singularity of the equation divided by Q does not, by itself, terminate the undivided hydrostatic system. Two converged static BVP solutions exist on opposite sides of the fold at the same test pressure.

Here “solution” means exactly a static solution of the stated boundary-value problem with the reported residuals and junction conditions. Dynamical stability is a different observable and is not part of the statement being made in this chapter.

16

The Fold Was Already Waiting

Why X_c becomes the natural continuation parameter

After the branch change, central pressure stops being a monotonic label. The natural continuation coordinate becomes the central curvature invariant X_c itself.

The v28 data around the fold show central energy increasing on the lower branch and decreasing on the upper branch. A local cubic reconstruction over the declared window $0.885 \leq X_c \leq 0.92$, performed without inserting the location of the extremum, gives

$$\left. \frac{d\varepsilon_c}{dX_c} \right|_{\star} = 0, \quad X_{c,\star} = 0.90524925, \quad \varepsilon_{c,\star} = 1.21203250.$$

Independent of that fit, the earlier homogeneous v24.1 calculation had given

$$X_{\text{sat}}^{\text{bulk}} = 0.90525591, \quad \varepsilon_{\text{sat}}^{\text{bulk}} = 1.21203543.$$

The differences are

$$|\Delta X| \simeq 6.7 \times 10^{-6}, \quad |\Delta \varepsilon| \simeq 2.9 \times 10^{-6}.$$

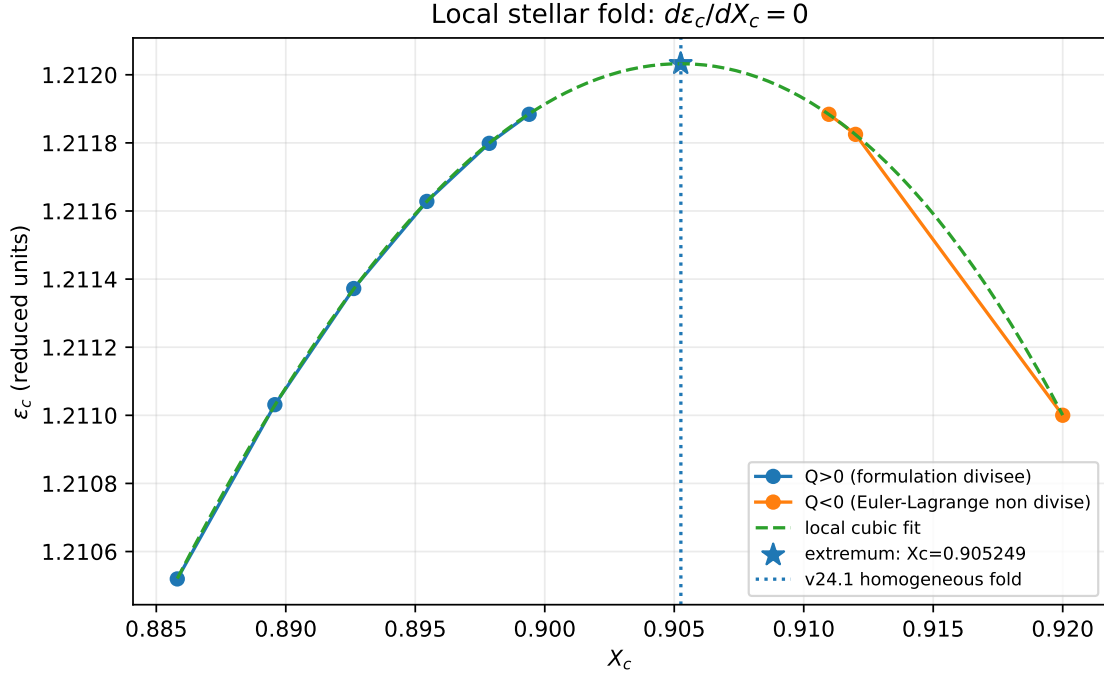


Figure 2: Local fold in the stellar continuation. The star marks the extremum of a cubic fit to the converged stellar data in the stated window. The vertical reference marks the independently derived homogeneous v24.1 fold. The proximity is a numerical fact of the current pre-audit; it is not imposed as an identity.

Quadratic and cubic reconstructions over several nearby windows place the extremum approximately in the ranges

$$0.90477 \lesssim X_{c,\star} \lesssim 0.90527, \quad 1.212015 \lesssim \epsilon_{c,\star} \lesssim 1.212044.$$

The v24.1 homogeneous marker lies inside that numerical envelope.

RESULT - The one-metre result

The stellar continuation independently reconstructs an extremum of $\epsilon_c(X_c)$ at the same location, to the current numerical precision, as the older homogeneous constitutive fold. This is the cleanest cross-version coincidence obtained by the N-EMPR line because the two calculations reached the number by different routes.

FALSIFICATION / LIMIT - Do not overread the coincidence

The centre of a hydrostatic star is not exactly a homogeneous bulk: $\chi'(0) = 0$ by regularity, while $\chi''(0)$ need not vanish. The agreement therefore motivates an independent reproduction; it does not license the statement that the stellar fold and the homogeneous fold are analytically identical.

17

Extreme Compactness and Cross-Method Confirmation

The v28 high branch and the regular $Q_c < 0$ solution reproduced by two solvers

The v28 continuation discovered the high-compactness branch. The post-v28 calculation then subjected the key $Q_c < 0$ state to two different numerical formulations. Shooting and two-domain collocation converge to the same regular solution. The branch is therefore presented here as a reproduced numerical structure of the frozen reduced model, while the original v28 sequence remains the chronological record of how it was first reached.

The refined high-branch sequence reported by v28 includes

X_c	p_c	Q_c	M	R	$2M/R$
0.9200	0.502282	-0.16360	0.862778	2.023051	0.85295
0.9400	0.499064	-0.47491	0.894878	1.963904	0.91133
0.9500	0.496040	-0.69833	0.931990	1.945592	0.95805
0.9600	0.491688	-1.00220	0.962858	1.957011	0.98401
0.9700	0.485478	-1.44881	0.972237	1.951329	0.99649
0.9715	0.484334	-1.53551	0.972448	1.949276	0.99775

The v28 high-branch continuation reached

$$X_c = 0.9715, \quad M = 0.972448, \quad R = 1.949276, \quad \frac{2M}{R} = 0.997753, \quad f_{\min} = 9.94 \times 10^{-3} > 0.$$

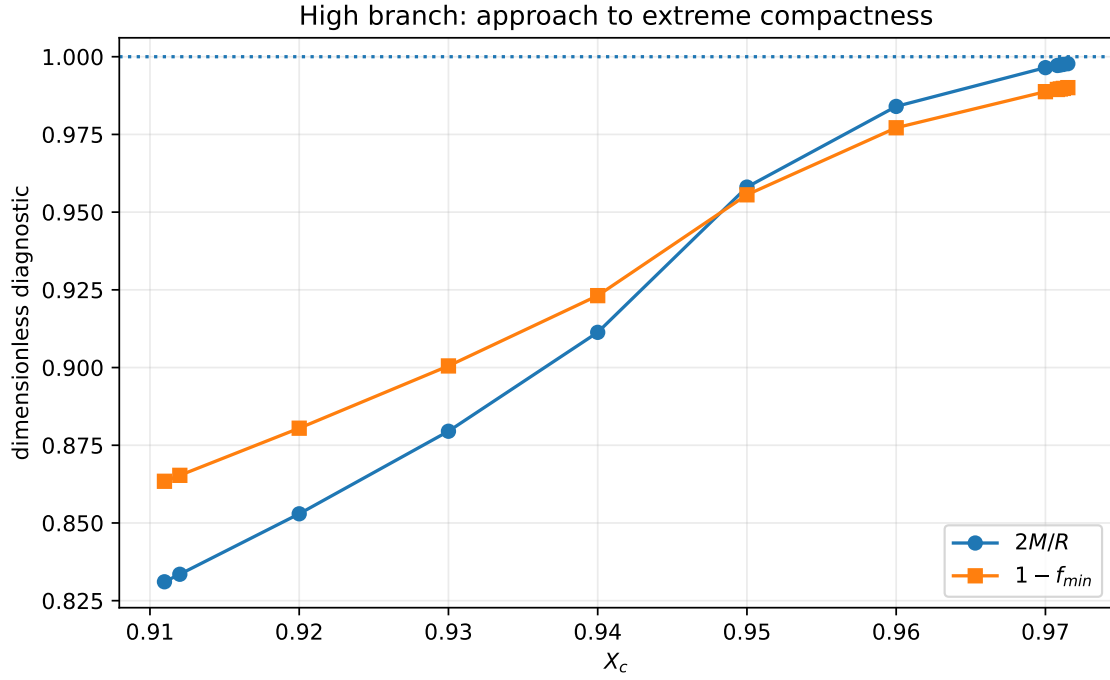


Figure 3: Two dimensionless diagnostics along the converged $Q < 0$ branch. The sequence approaches extreme compactness while the local metric function still retains a positive minimum at the last accepted point.

Across the displayed v28 continuation the mass remains increasing and the local metric function stays positive through the last retained point. The sequence therefore records an approach to extreme compactness inside the declared reduced model without a reported $f = 0$ event in the displayed domain.

CA-1: cross-method confirmation of the regular $Q_c < 0$ solution

At the same test pressure $p_c = 0.5028$, the post-v28 DOP853 shooting implementation reports

$$\chi_c = 1.201356564122, \quad R = 2.08849775, \quad M = 0.84685706,$$

with a smooth $Q = 0$ crossing near $r_Q = 0.5148433$ and a shallow pressure maximum $p_{\max} = 0.5028824$ near $r = 0.4982$.

A separately implemented two-domain collocation gives

$$X_c = 0.9109684074, \quad Q_c = -0.0598152950, \quad R = 2.0884976108, \quad M = 0.8468571424,$$

with $\max |H|$ below 8×10^{-14} in both domains. The two post-v28 radii differ by only about 1.4×10^{-7} , whereas the frozen v28 point at the same central pressure reports $R = 2.046754$.

RESULT - CA-1 branch-existence verdict

At $p_c = 0.5028$, DOP853 shooting and two-domain collocation reproduce the same regular $Q_c < 0$ solution, including its smooth internal $Q = 0$ crossing. The branch is therefore cross-method reproducible. At this test pressure the concordant global values are $R \simeq 2.0884976$ and $M \simeq 0.8468571$; the earlier v28 coordinates remain in the dated audit record.

PART VI

THE COSMIC BOUNDARY

v29: when the constitutive length fixes the cost of new volume



18

The Border Is Not the Interior

A volume ledger before a cosmological claim

A boundary can advance while every distance inside the old domain remains unchanged. The first global discipline of v29 is therefore to stop calling boundary growth “the Hubble expansion” before an interior response law has been derived.

The global branch keeps the two notions separate from the first line. Let Γ_{∂} denote the rate at which new State $\mathcal{A}$ volume is formed at the boundary, while $\Theta_{\mathcal{A}}(\mathbf{x}, T)$ denotes the local volumetric dilation rate of the already existing interior continuum. The exact kinematic ledger is

$$\dot{V}_{\mathcal{A}} = \int_{\Omega(T)} \Theta_{\mathcal{A}}(\mathbf{x}, T) dV + \Gamma_{\partial}.$$

For a homogeneous interior,

$$\Theta_{\mathcal{A}} = 3H_{\text{int}},$$

so

$$\frac{1}{3} \frac{\dot{V}_{\mathcal{A}}}{V_{\mathcal{A}}} = H_{\text{int}} + \frac{\Gamma_{\partial}}{3V_{\mathcal{A}}}.$$

This identity carries a simple physical warning. The total-domain rate $\dot{V}_{\mathcal{A}}/(3V_{\mathcal{A}})$ and the observed interior Hubble rate are not the same object by definition. In the spherical representation,

$$V_{\mathcal{A}} = \frac{4\pi}{3} R_{\mathcal{A}}^3, \quad A_{\partial} = 4\pi R_{\mathcal{A}}^2,$$

and the radius obeys

$$\dot{R}_{\mathcal{A}} = H_{\text{int}} R_{\mathcal{A}} + v_{\partial}, \quad v_{\partial} \equiv \frac{\Gamma_{\partial}}{A_{\partial}}.$$

The benchmark “boundary only” is the special case $H_{\text{int}} = 0$. It is useful because it isolates what the edge itself can do; it is not a substitute for the missing interior response.

PRINCIPLE - Boundary/interior separation

RM may calculate Γ_{∂} from a boundary ledger without thereby calculating H_{obs} . A derivation of cosmological expansion requires an independently obtained map from the boundary source to the homogeneous interior mode.

19

Radiation Reaches a Moving Boundary

The edge cannot outrun the source that feeds it

The familiar isotropic flux $cu_\gamma/4$ belongs to a stationary surface. Once the boundary itself moves, only photons with a sufficient outward directional component can catch it.

Let $\mathcal{P}_{\gamma,\partial}$ be the electromagnetic power effectively absorbed at the boundary. Before choosing an ideal branch, the ledger is

$$\mathcal{P}_{\gamma,\partial} = \mathcal{P}_\partial + \mathcal{P}_{\text{refl}} + \mathcal{P}_{\text{store},\partial} + \mathcal{P}_{\text{other}}.$$

The benchmark used in v29 is the strong ideal-absorption branch

$$\mathcal{P}_{\text{refl}} = \mathcal{P}_{\text{store},\partial} = \mathcal{P}_{\text{other}} = 0, \quad \mathcal{P}_\partial = \mathcal{P}_{\gamma,\partial}.$$

This is a declared boundary condition, not a theorem about a yet-unmeasured cosmic interface.

If forming a new boundary volume dV_∂ costs the marginal work $\mathcal{U}_\partial dV_\partial$, then

$$\mathcal{U}_\partial \Gamma_\partial = \mathcal{P}_{\gamma,\partial}.$$

The equation pays only for the boundary term Γ_∂ ; it does not automatically pay the interior term $\int \Theta_\mathcal{E} dV$.

For an isotropic radiation field of energy density u_γ and a boundary moving with physical speed v , only directions $\mu > v/c_\mathcal{E}$ catch the surface. The absorbed flux is

$$F_{\gamma,\partial}(v) = \frac{c_\mathcal{E} u_\gamma}{4} \left(1 - \frac{v}{c_\mathcal{E}}\right)^2.$$

In the boundary-only benchmark $v = v_\partial = \dot{R}_\mathcal{E}$. The corresponding implicit law always satisfies

$$0 < v < c_\mathcal{E}.$$

As the formation cost becomes small compared with the radiation density, the boundary approaches $c_\mathcal{E}$ from below; it never overtakes the radiation that supplies it.

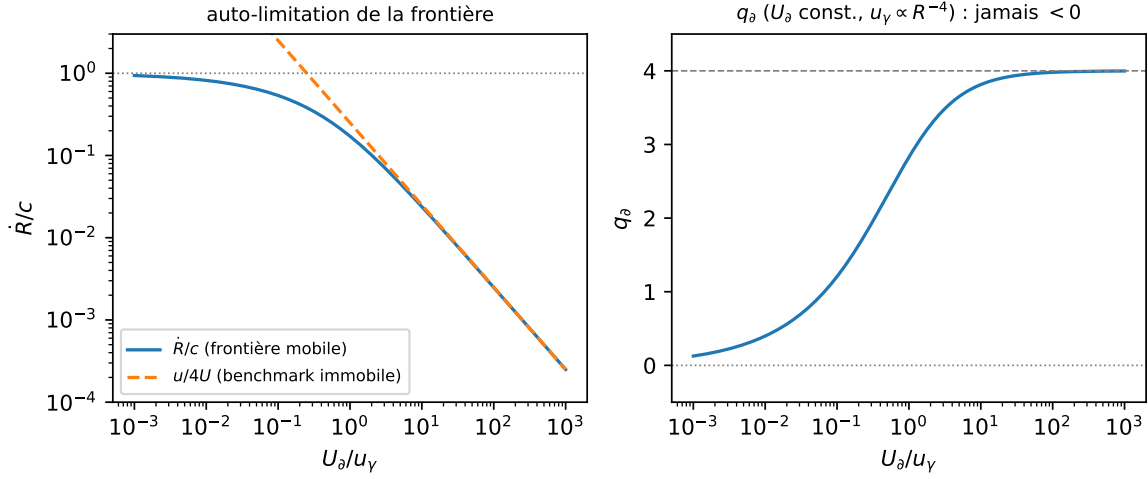


Figure 4: Moving-boundary benchmark. Left: the exact boundary speed asymptotes below c_E while the stationary-surface approximation diverges outside its domain. Right: with constant formation work and the homothetic benchmark $u_\gamma \propto R_E^{-4}$, the boundary deceleration parameter remains non-negative. This is a boundary test, not a derivation of interior cosmic acceleration.

RESULT - Moving-boundary no-go

With constant formation work, the simplest radiative boundary benchmark does not generate an accelerating edge. Under $u_\gamma \propto R_E^{-4}$, q_∂ runs from 4 toward 0 and never becomes negative. Any observed interior acceleration must therefore come from physics beyond this boundary-only constant-cost benchmark.

20

The Price of New Volume

A natural scale is not yet a complete formation law

The action already contains the dimensional scale needed to express a marginal cost per unit volume. That fact is useful. It does not by itself prove that the complete cost of creating a new physical region equals that scale with unit coefficient.

The gravitational normalization used in the TOV recovery is

$$P = \frac{c_E^4}{16\pi G_N}, \quad [P] = \text{J m}^{-1}.$$

The curvature sector carries the constitutive length $\ell_\star$ through

$$X_{\mathcal{R}} = \ell_\star^4 \mathcal{R}_{ij} \mathcal{R}^{ij},$$

so the same architecture contains the natural volumetric scale

$$u_{\text{geom},\star} = \frac{P}{\ell_\star^2}.$$

The historical v29 branch adopted the unit identification

$$\mathcal{U}_\partial = \frac{P}{\ell_\star^2}.$$

In the current corpus this is retained as a **conditional constitutive boundary hypothesis**. If it is adopted, then

$$\mathcal{K}_{\text{cryst}} = \frac{\ell_\star^2}{P}$$

follows algebraically and introduces no additional dimensional constant. The algebraic consequence is exact; the unit identification that activates it is not promoted into an action-level theorem.

Combining that branch with the ideal absorbed-flux ledger gives

$$\Gamma_\partial = \frac{\ell_\star^2}{P} \mathcal{P}_{\gamma,\partial}, \quad v_\partial = \frac{\ell_\star^2}{P} F_{\gamma,\partial}.$$

These equations are useful boundary benchmarks. They do not identify the marginal formation cost with the residual energy density of newborn volume, and they do not include layer storage, outgoing products or work exchanged with other sectors unless those terms are written explicitly.

STATUS - Status of the unit boundary coefficient

$P/\ell_\star^2$ is the natural RM volumetric scale. The statement $\mathcal{U}_\partial = P/\ell_\star^2$ is a conditional unit branch. A complete boundary action may confirm it, derive a different coefficient, or require additional formation terms. No coefficient may be fitted to H_0 merely to preserve the branch.

21

Three Ledgers, No Hidden Equivalence

Thermal loading, redshift propagation and boundary production

The current energy hierarchy is not “redshift or temperature”. Both remain physical, but they do not carry the same burden. Thermal–radiative loading is primary in the active stellar interpretation; redshift remains a propagation observable and a possible secondary energetic contribution; boundary production is a third, inhomogeneous process.

In the stellar thermal branch,

$$u_\gamma = a_R \Theta^4, \quad \varepsilon_{\mathcal{A}}^{\text{th}} = \varepsilon_{\mathcal{A}}^{\text{th}}(e).$$

The thermal reservoir is not obtained by renaming the historical symbol ε_z . Conversely, a nonzero redshift is not set to zero merely because it is no longer assigned the dominant energetic role. A future complete ledger may contain a redshift-related transfer term, but its sign, receiver and quantitative

share must be derived.

The boundary rate remains distinct:

$$\Gamma_{\partial} : \text{production of new manifested volume.}$$

In the ideal absorbed-flux benchmark,

$$\mathcal{U}_{\partial}\Gamma_{\partial} = \mathcal{P}_{\gamma,\partial},$$

but this is a boundary condition on a selected branch, not a statement that every thermal or redshift contribution is converted at the edge.

PRINCIPLE - No fitted partition

Book I assigns no percentage to the thermal and redshift channels. The shorthand intuition that one contribution may dominate another is not a coefficient. A number such as “92/8” earns a place in an equation only after a derivation independently fixes it.

The same absorbed photons also carry momentum. In the isotropic moving-boundary benchmark,

$$\Pi_{\gamma,\partial}(\beta) = \frac{u_{\gamma}}{12}(1 - \beta)^2(\beta + 2), \quad \beta = \frac{v}{c_{\mathcal{E}}}.$$

Energy, momentum, thermal storage, redshift propagation and volume formation remain separate ledgers unless an explicit action or balance law couples them.

22

The Bulk Closes; the Bridge Remains Open

HBR-1 survives, thermal loading extends it, formation stays separate

The later bulk audit changes the hierarchy without erasing the theorem. The original homogeneous closure remains the exact reduced $U = 0$ result. The thermal branch adds new constitutive content and therefore a new conditional equation; it is not a retroactive relabelling of the old reservoir.

For the reduced homogeneous theorem, with

$$B(e) = 2\varepsilon_z(e) + 3\varepsilon'_z(e),$$

constraint preservation gives

$$H [3B'(e) + 3\rho_m + 8u_{\gamma}] = s.$$

This is HBR-1. It derives the deep-bulk rate under its declared matter-radiation ledger without importing a Friedmann equation, H_0 , Ω_m or a fitted homogeneous response coefficient.

In the thermal completion, define

$$B_{\text{th}}(e) = 2\varepsilon_{\mathcal{E}}^{\text{th}}(e) + 3(\varepsilon_{\mathcal{E}}^{\text{th}})'(e),$$

and retain the curvature-Exclusion energy $U(X)$. On the stated homogeneous scale-factor branch, $\dot{X} = -4HX$, and preservation of the corrected constraint gives

$$H [3B'_{\text{th}}(e) + 8XU'(X) + 16X^2U''(X) + 3\rho_m + 8u_\gamma] = s.$$

For $U = 0$ the equation reduces to HBR-1.

The Maria construction then supplies a conditional thermal capacity statement. Under the working capacity postulate UC-1,

$$u_{\mathcal{A}}^{\text{cap}} = \frac{P}{\ell_\star^2},$$

the homogeneous reduction gives the upper radiative load

$$u_\gamma \leq \frac{5P}{4\ell_\star^2} - u_0,$$

and therefore

$$\Theta \leq \left[\frac{1}{a_R} \left(\frac{5P}{4\ell_\star^2} - u_0 \right) \right]^{1/4}.$$

UC-1 is a postulate and the equality need not be attained. The further identification

$$\Theta \rightarrow \Theta_{\text{Maria}} \implies \text{LF-09 channel closure} \implies EM \rightarrow \mathcal{A}$$

is a working constitutive bridge. The microscopic conversion law, efficiency and entropy production remain open.

The total manifested-volume rate still separates deep bulk and boundary production,

$$H_{\mathcal{A}} = H + g_\partial, \quad g_\partial = \frac{\Gamma_\partial}{3V_{\mathcal{A}}}.$$

The off-center mechanical audit adds a further safeguard: matched birth is derived only in the reduced $U = 0$ homogeneous branch under its stated balances, and the full formation cost is not the same quantity as the density left in newborn volume.

RESULT - Current bulk status

The homogeneous Hamiltonian debt is closed at bulk level under the stated assumptions: HBR-1 is the reduced theorem and the thermal equation above is its conditional extension. What remains open is the microscopic thermal-to- $\mathcal{A}$ conversion law, the quantitative secondary redshift contribution, boundary formation physics, perturbations and the observational transfer operators.

PART VII

THE PHOTONIC STEP

v34.1: when cadence becomes a cost along a random walk



23

The Step Has Three Owners

Matter, cadence and spatial structure must not be fused

The sentence arrived before the correct equation: “Matter determines the length of the photon’s step; State $\mathcal{A}$ determines the cadence of that step.” The first v34 calculation fused two different physical roles into one attractive optical factor. Adversarial reconstruction then forced the factors apart and exposed the simpler structure that survives: material diffusion belongs to the generator, cadence belongs to the Dynkin cost, and spatial relational structure belongs to the proper geometry.

Pillar II already carries the cadence map

$$d\tau_{\text{cad}} = N dT, \quad N > 0,$$

and the electromagnetic principal symbol

$$\mathfrak{P}(\omega, k; x) = \frac{\omega^2}{N^2 c_{\mathcal{A}}^2} - g^{ij}(x) k_i k_j = 0.$$

In the isotropic representative $g_{ij} = A(r)\delta_{ij}$ with $A = 1 + \psi$, the coordinate velocity contains both a temporal conversion and a spatial one,

$$v_{\text{coord},T} = \frac{N}{\sqrt{A}} v_{\text{prop},\text{loc}}.$$

The factor N is cadence. The factor $A^{-1/2}$ converts proper length to coordinate length. Calling their product “cadence” was the first v34 error.

The local material random walk is described instead by its own Fick coefficient D_{loc} . The clean separation is therefore

$$\begin{aligned} D_{\text{loc}} &\longrightarrow \text{material microphysics and step statistics,} \\ N &\longrightarrow \text{cadence relative to universal time } T, \\ g_{ij}(\psi) &\longrightarrow \text{relational spatial structure.} \end{aligned}$$

FALSEFICATION / LIMIT - Two errors kept visible

The original v34 form $\nabla \cdot [(D_{\text{std}}/n_{\text{opt}})\nabla\Theta] = -1$ is withdrawn because it mixes proper and coordinate measures. The first counter-audit form $\nabla \cdot (ND_{\text{loc}}\nabla\Theta) = -1$ is also withdrawn because it generates an additional drift term proportional to ∇N . Neither error is deleted from the audit history.

24

Dynkin Puts N on the Right Side

The same spatial walk, accumulated on the universal time line

A variation of cadence should change how long the same local process takes relative to T . It should not manufacture a new spatial force merely because N varies with position.

Let the local radiative random walk be generated, per unit proper-cadence parameter τ_{cad} , by

$$\mathcal{L}_{\text{loc}} f = \nabla_i \left(D_{\text{loc}} \nabla^i f \right).$$

If X_τ is that local process and τ_{exit} its first exit time, universal time accumulates along the realised path as

$$\Theta(x) = \mathbb{E}_x \left[\int_0^{\tau_{\text{exit}}} \frac{d\tau_{\text{cad}}}{N(X_\tau)} \right].$$

Dynkin's formula then fixes the mean escape-time equation:

$$\nabla_i \left(D_{\text{loc}} \nabla^i \Theta \right) = -\frac{1}{N}, \quad \Theta|_{\partial\Omega} = 0.$$

Equivalently, the generator referred to T is $\mathcal{L}_T = N\mathcal{L}_{\text{loc}}$, with N multiplying the generator from outside rather than being placed inside the divergence.

For the isotropic spherical representative $g_{ij} = A(r)\delta_{ij}$,

$$\frac{1}{A^{3/2}r^2} \frac{d}{dr} \left[r^2 A^{1/2} D_{\text{loc}} \Theta' \right] = -\frac{1}{N}.$$

Regularity at the centre gives

$$\Theta'(r) = -\frac{1}{r^2 A(r)^{1/2} D_{\text{loc}}(r)} \int_0^r \frac{x^2 A(x)^{3/2}}{N(x)} dx.$$

Exchanging the order of integration yields

$$\Theta(0) = \int_{B(R)} \frac{1}{N(x)} K(x) dV_{\text{prop}},$$

where

$$K(r) = \int_r^R \frac{dr'}{4\pi r'^2 A(r')^{1/2} D_{\text{loc}}(r')} > 0.$$

RESULT - N-OPT-01.1 – weighted-cadence theorem on a frozen background

Let Θ_N be the solution above and $\Theta_{N=1}$ the same problem with the same g_{ij} and D_{loc} but N

replaced only by unity. Then

$$\frac{\Theta_N(0)}{\Theta_{N=1}(0)} = \left\langle \frac{1}{N} \right\rangle_{K dV_{\text{prop}}},$$

and therefore

$$\min \frac{1}{N} \leq \frac{\Theta_N(0)}{\Theta_{N=1}(0)} \leq \max \frac{1}{N}.$$

The theorem isolates cadence. It does not compare two complete stellar models because the geometry and material diffusion profile are deliberately held fixed.

25

The Photonic Step Becomes an Equation

The Dynkin theorem and the 226,000 km/s intuition

Once N is placed as the Dynkin cost rather than hidden inside a diffusion coefficient, the photonic-cadence idea becomes an exact first-passage statement on any frozen spatial/material background satisfying the stated Fick assumptions. The benchmark below does not apologise for the theorem; it shows why the placement of cadence matters and why only one placement reproduces the universal-time expectation.

The counter-audit benchmark uses a purely algebraic sphere with flat geometry, $D_{\text{loc}} = 1$, $R = 1$ and $N(r) = \sqrt{1 - C_c(1 - r^2)}$. Three placements of cadence give three different answers; only the Dynkin placement is the expected universal-time cost of the local walk.

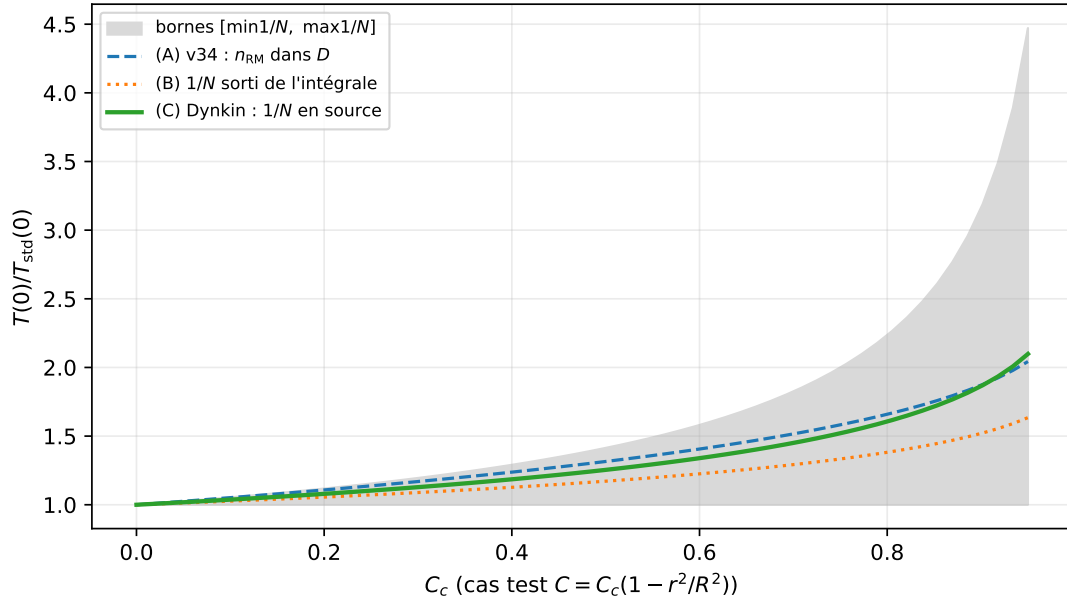


Figure 5: Counter-audit benchmark for the three placements of cadence. The Dynkin solution remains inside the positive bounds $[\min(1/N), \max(1/N)]$. This is an algebraic transport test, not a stellar model.

Two numerical references are deliberately kept as references only. On the weak solar marker used in Pillar II, $C(0) = 1.81 \times 10^{-5}$ and the exterior identity $N^2 = 1 - C$ would give

$$\frac{1}{N} - 1 \simeq 9.05 \times 10^{-6},$$

which is far too small to make ordinary solar diffusion an RM-dominated effect. This is not an interior solar transport calculation.

The earlier intuition $226\,000 \text{ km s}^{-1}$ also acquires a cleaner meaning. If it denotes proper distance travelled per unit universal time in a local regime where $v_{\text{prop,loc}} \simeq c_{\mathcal{A}}$, then

$$N = 0.7538548551, \quad \frac{1}{N} = 1.3265153009.$$

Only if one additionally imports the exterior reference $N^2 = 1 - C$ does this correspond algebraically to $C = 0.4317028574$. It is not a stellar measurement, calibration or strong-field prediction.

RESULT - The mathematical content of N-OPT-01

The Dynkin theorem is complete at the level at which it is stated. Given a local Fick generator on the proper spatial geometry and the RM cadence map $d\tau_{\text{cad}} = N dT$, the universal-time first-passage equation is forced to be $\mathcal{L}_{\text{loc}}\Theta = -1/N$. No microscopic stellar model is required to establish that theorem. A specific stellar plasma supplies an application by providing $D_{\text{loc}}(r)$, $N(r)$ and $g_{ij}(r)$; it does not alter the mathematical statement already derived.

PRINCIPLE - The sentence that survived the inquisition

Matter determines the statistics of the photon's step; State $\mathcal{A}$ determines the cadence of that step and the spatial structure in which it is taken.

EPILOGUE

The Book Closes; the Results Stand

Book I now closes on results with their status made explicit. Version 4.1.0 reached the stellar fold. Version 5.0.0 introduced the natural boundary scale $P/\ell_\star^2$ and the unit-cost branch. Version 5.2.0 added two consolidations: the regular $Q_c < 0$ stellar solution became a cross-method numerical result, and the photonic-cadence intuition became the Dynkin first-passage theorem. Version 5.3.0 adds the homogeneous HBR-1 closure, the thermal/Maria concordance and the corrected status of boundary formation cost. The sequence of failed or superseded intermediate equations is retained because it shows that the surviving forms were not purchased by silent repair.

The story still begins with refusal. A symbol is not allowed to become a physical object merely because the notation permits it. The programme then broke its own rule: a beautiful nuclear construction almost acquired the right to survive because it produced the desired scale. The branch was killed. That death separated matter from State $\mathcal{A}$ and redirected the work toward the imprint of matter on the continuum.

From that redirection came the N-EMPR chain: matter imprint, cadence, exact integrated identity, hydrostatic pressure, standard-TOV recovery, a first mass-radius sequence, the discovery that division by Q had hidden a branch, and finally a stellar fold numerically coincident with an older homogeneous constitutive-limit marker obtained by another route. Only after v28 was frozen did the next interpretation become obvious: the breadcrumb was $\ell_\star$ itself. RM had already placed a constitutive length in its geometry, and the high-curvature response could therefore be read as an Exclusion Interaction rather than as a phenomenological correction added to matter.

The global branch repeats the same lesson at a different scale. The first attempt introduced a boundary formation work $\mathcal{U}_\partial$ and therefore looked as though a new “crystallization constant” might have to be purchased. The action already contains P , the gravitational energy-per-length coefficient, and $\ell_\star$, the constitutive length, so $P/\ell_\star^2$ supplies the required volumetric scale without inventing a new dimensionful constant. The historical unit branch sets

$$\mathcal{U}_\partial = \frac{P}{\ell_\star^2}, \quad \mathcal{K}_{\text{cryst}} = \frac{\ell_\star^2}{P} = \frac{16\pi G_N \ell_\star^2}{c_{\mathcal{A}}^4}.$$

The second relation is then an algebraic consequence of the first. The current corpus no longer promotes the unit identification itself into a complete formation theorem: the off-center mechanical audit separates marginal addition, newborn storage, layer storage, outgoing products and exchanged work.

The photonic branch repeats the lesson at the level of a single random walk. The first attempt put the optical index inside a diffusion coefficient; the counter-audit removed the geometric half-factor but put N inside the divergence, creating a fictitious drift. The surviving equation is simpler:

$$\boxed{\nabla_i (D_{\text{loc}} \nabla^i \Theta) = -1/N.}$$

Matter supplies the local diffusion statistics, N supplies the cadence cost, and g_{ij} supplies the spatial structure. Under the stated Fick and cadence hypotheses, the first-passage theorem is exact and parameter-free.

There is an irony worth preserving. The chapter once presented as RM’s most embarrassing failure

became the mechanism that prevented later numerical success from being purchased with an arbitrary constant. The same discipline now prevents the cosmic boundary from being rescued with an efficiency fitted to H_0 . The “Trojan Horse” did not conquer an institution. It conquered the programme’s own desire to be right too early.

“The result worth defending is not the one that survived praise. It is the one that survived the attempt to remove it.”

For public communication, Book I can now state three discoveries with precision. The regular $Q_c < 0$ solution is reproduced by two different numerical formulations at the declared test pressure. N-OPT-01 v34.1 gives the exact Dynkin cadence theorem on a frozen material/spatial background. The homogeneous bulk audit derives HBR–1 from the surviving zero-mode constraints and the current revision preserves its exact $U = 0$ status while receiving the conditional thermal extension. The unit boundary-cost branch and the Maria-to- $EM \rightarrow \mathcal{A}E$ bridge remain visibly conditional rather than being promoted by rhetoric.

This is not a request for belief and not a request for institutional indulgence. It is a statement of results with their derivations left exposed. The v28 stellar record, cross-method reproduction, Dynkin theorem, bulk closure, thermal extension and boundary mechanics are kept in an append-only chain so that any reader can identify exactly which assumption produced which claim. RM does not protect a result by rhetoric; it protects the integrity of the record by refusing silent repair.

RESULT - Status of Book I v5.3.0

Thermal/Bulk Concordance edition. Pillar I records the epistemological genesis of RM, the discipline of non-repair, the separation of physical prerogatives, the constitutive-length / Exclusion reading, the stellar Q -fold, the cross-method reproduction of the regular $Q_c < 0$ solution, the v34.1 N-OPT-01 Dynkin theorem, the reduced homogeneous HBR–1 closure, the conditional thermal/Maria completion, and the corrected status of boundary formation cost. Redshift remains a physical observable and possible secondary energetic channel, not the primary stellar loading by assumption. Detailed gravitational derivations remain under Pillar II authority and constitutional statements under Pillar IV authority.

APPENDIX A

Current Status Register

This register states the active architecture of Book I and the level at which each result is asserted.

Object	Status	Meaning in v5.3.0
Universal open time	RM postulate	Clock differences are read as physical cadence differences, not as a material deformation of time.
State $\mathcal{A}$	RM postulate	Physical relational continuum of the manifested domain; distinct from matter and from Silentium.
Constitutive length ℓ_*	Action-level RM input	Enters $X_{\mathcal{R}} = \ell_*^4(a^2 + 2b^2)$ before any stellar EOS is selected. No kilometre calibration is claimed in Book I.
Exclusion Interaction	Constitutive interpretation	New name in v4.1.0 for the nonlinear geometric response approaching $X_{\mathcal{R}} = 1$; not Pauli exclusion, not an added force coefficient.
Silentium	Canonical ideal limit	External ideal limit, not another name for State $\mathcal{A}$ and not a fifth physical substance.
Nuclear-droplet branch	Rejected historical branch	Preserved only as the non-repair audit that forced the matter/ $\mathcal{A}$ separation.
N-EMPR-01	Derived in audited class	Matter loads the relational field onto the $\chi \geq 1$ side of the branch.
v25 cadence identity	Exact static identity	$d \ln(NQ/\sqrt{f})/dr = \mathcal{S}$.
TOV-RM v26	Derived conditional closure	Hydrostatic system closes for a specified EOS under the minimal matter interface.
Standard TOV limit	Exact non-regression result	Recovered with $Z = 1$, $G = 0$, $\chi' = 0$, $Q = P$ and no added coefficient.
v27 mass-radius sequence	Conditional numerical result	Toy EOS, reduced units; RM branch more compact than the TOV control on the computed interval.
$Q_c < 0$ stellar branch	Cross-method reproduced numerical result	DOP853 shooting and two-domain collocation recover the same regular high-side solution at $p_c = 0.5028$; the dated v28 coordinates are preserved as the discovery record.
Stellar fold	Post-v28 numerical reconstruction	$X_{c,*} \simeq 0.905249$, $\varepsilon_{c,*} \simeq 1.212032$ from local fits to converged data.
v28 high-compactness continuation	Historical numerical discovery record	The displayed continuation reaches $X_c = 0.9715$ and $2M/R = 0.997753$ with $f_{\min} > 0$ in the v28 implementation; the record is preserved append-only.
Astrophysical neutron-star prediction	Outside the claim of Book I	No km or $M_{\odot}$ interpretation is assigned to the toy-EOS reduced-unit sequence.

Object	Status	Meaning in v5.3.0
CA–1 stellar cross-check	Cross-method confirmation	DOP853 shooting and two-domain collocation reproduce the regular $Q_c < 0$ solution near $R = 2.0884976$ at $p_c = 0.5028$, including the smooth internal $Q = 0$ anatomy.
N-OPT-01 v34.1	Conditional analytic transport result	On a frozen $\{g_{ij}, D_{\text{loc}}\}$ background, $\nabla_i(D_{\text{loc}}\nabla^i\Theta) = -1/N$ and $\Theta_N/\Theta_{N=1} = \langle 1/N \rangle_{KdV}$.
Boundary/interior split	Exact kinematic ledger	$\dot{V}_{\mathcal{E}} = \int \Theta_{\mathcal{E}} dV + \Gamma_{\partial}$; boundary production is not identified with the observed interior Hubble rate.
Moving-boundary flux	Derived benchmark	$F_{\gamma,\partial} = (c_{\mathcal{E}}u_{\gamma}/4)(1 - v/c_{\mathcal{E}})^2$ for the stated isotropic benchmark; the boundary remains below $c_{\mathcal{E}}$.
Unit boundary formation scale	Conditional constitutive branch	$P/\ell_{\star}^2$ is the natural volumetric scale; the identification $\mathcal{U}_{\partial} = P/\ell_{\star}^2$ remains conditional and is not a newborn residual density.
Crystallization coefficient	Algebraic consequence of unit branch	If the unit boundary identification is adopted, $\mathcal{K}_{\text{cryst}} = \ell_{\star}^2/P = 16\pi G_N \ell_{\star}^2/c_{\mathcal{E}}^4$; no additional dimensional constant is then required.
HBR–1 homogeneous bulk rate	Formal result on reduced $U = 0$ branch	$H[3B' + 3\rho_m + 8u_{\gamma}] = s$ follows from preservation of the surviving homogeneous constraint under the declared ledger.
Thermal/Maria completion	Conditional closure plus working bridge	Thermal–radiative loading is primary in the active stellar reading; the $U(X)$ extension reduces to HBR–1 at $U = 0$. Maria supplies a conditional bound; Maria-limit $\rightarrow EM \rightarrow \mathcal{E}$ remains open microscopically.
Redshift energetic share	Open quantitative sector	Redshift remains a genuine propagation observable and possible secondary continuum-work channel; no fixed fraction, sign or receiver term is assumed.
Interior expansion law	Bulk closed / boundary coupling separate	HBR–1 closes the deep reduced bulk under its assumptions; boundary production, formation physics, perturbations and transfer to observables remain distinct sectors.

APPENDIX B

Falsification Triggers Carried Forward

Claimed structure	What would remove it
TOV-RM hydrostatic closure	Failure of the minimal matter interface to reproduce the relabelling identity or the derived pressure contribution.
Standard TOV recovery	Failure to recover both the mass and pressure equations when the RM sectors are switched off.
Second $Q < 0$ branch	An independent implementation of the undivided equations fails to reproduce a converged $Q_c < 0$ solution near the stated test pressure.
Double solution at $p_c = 0.5028$	Either solution disappears under domain extension, mesh refinement or a genuinely independent continuation method.
Fold coincidence	The reconstructed extremum moves outside the reported numerical envelope under independent reproduction or the v24.1 homogeneous marker is found to have been derived with a hidden common input.
v28 high-compactness continuation	A reproducible implementation of the same v28 continuation shows that the displayed sequence or its constraint closure was numerical rather than a solution of the stated equations.
Cross-method $Q_c < 0$ solution	A separately implemented solver of the same undivided equations, central data and boundary problem systematically fails to recover the regular branch.
N-OPT-01 Dynkin cadence theorem	Within the stated hypotheses it is an exact consequence of the local Fick generator and $d\tau_{\text{cad}} = N dT$; it fails only if those hypotheses do not describe the physical regime under consideration.
Frozen-background inequality	Fails if the kernel loses positivity, $D_{\text{loc}} \leq 0$ in the stated diffusive domain, or the first-passage problem is not finite.
Boundary/interior separation	A correct kinematic derivation shows that the decomposition $\dot{V}_{\mathcal{E}} = \int \Theta_{\mathcal{E}} dV + \Gamma_{\partial}$ is not the appropriate volume ledger for the stated moving domain.
Unit boundary-cost branch	A complete boundary derivation fails to support $\mathcal{U}_{\partial} = P/\ell_{\star}^2$, or shows that additional formation terms prevent the unit relation from representing the relevant cost.
No-new-constant claim	A genuinely independent dimensional scale is required by the boundary dynamics and cannot be reduced to existing RM constants.
Energy hierarchy	A complete derivation shows that the thermal reservoir, any redshift-related transfer and boundary production cannot be separated consistently, or contradicts the stated sign/receiver bookkeeping.

APPENDIX C

Reproducibility Snapshot and Source Hierarchy

Book I is the methodological authority, not the primary source for every technical line. The following hierarchy prevents the manifesto from silently rewriting the calculation.

1. **Pillar I v5.3.0** - epistemological discipline, anti-circularity, historical genesis and separation of physical prerogatives.
2. **Pillar II v4.6.0** - primary technical authority for the gravitational sector, electromagnetic principal symbol, Pure Cadence map, CA-1 and the technical strong-field corpus.
3. **Pillar III v7.4.0** - current synthesis of the active architecture, Exclusion Interaction, stellar fold and strong-field status.
4. **Pillar IV v7.2.0** - constitutional authority for ontology, laws, Exclusion Interaction and the non-repair discipline.
5. **The Uncollapsing Universe: Constitutive Exclusion and Homogeneous Bulk Closure in Relativity of Matter, v4.0.0** - narrow authority for GHC-1, GEC-1, HBR-1, the conditional thermal extension, Maria-bound status and the thermal/redshift hierarchy; DOI [10.5281/zenodo.22791787](https://doi.org/10.5281/zenodo.22791787).
6. **The Exclusion Interaction in Relativity of Matter, v1.0.0** - canonical EI-1 statement and its dependent first-passage reading; DOI [10.5281/zenodo.22793642](https://doi.org/10.5281/zenodo.22793642).
7. **Geometry Is Not Enough: Mechanical Constraints on Off-Center Cosmic Observables, v5.1.0** - current mechanical concordance for matched birth on the reduced $U = 0$ branch, formation-cost separation, Core mechanics and the stationary redshift transfer law.
8. **N-EMPR v25-v28 plus the CA-1 cross-method record** - dedicated technical notes and separately implemented solvers carrying the cadence identity, TOV-RM closure, stellar sequence, smooth $Q = 0$ anatomy and cross-method confirmation of the regular $Q_c < 0$ solution.
9. **N-OPT-01 v34.1** - dedicated radiative-transport note carrying the Dynkin equation, the weighted-cadence theorem and the benchmark that distinguishes the three possible placements of N .
10. **RM-G1 / v29** - historical boundary benchmark carrying the moving-boundary ledger and the unit-cost branch. Its unit identification is retained conditionally and is not allowed to outrank the later formation-cost analysis.

The v28 stellar calculation remains frozen: no numerical point, solver equation or branch datum is altered by the later bulk, thermal or boundary updates. Parts VI and VII receive newer status information without retroactively changing the stellar computation. In particular, ε_z in an explicitly defined global-elastic model is not silently renamed $\varepsilon_E^{\text{th}}$, and the reduced $U = 0$ birth theorem is not extended to the thermal branch without a new derivation.

Reproducibility statement. No external human implementation of the stellar calculation is claimed in this edition. Within the present computational corpus, DOP853 shooting and two-domain collocation use different numerical formulations and converge on the same regular $Q_c < 0$ solution at the declared test pressure. This cross-method agreement is the basis of the branch-existence claim. The dated v28 coordinates remain preserved in the historical record. Part VI and Part VII are logically separate results and do not depend on assigning a physical endpoint to the v28 high-compactness continuation.

The reduced stellar calculations use the frozen pre-audit parameters

$$\kappa_\chi = 1, \quad \kappa_W = 10, \quad P = 0.5933438771, \quad u_\star = 1, \quad \ell_\star = 1.$$

No parameter in this tuple was changed after the v27/v28 curves were seen.

The fold estimate reported in Chapter 16 was reconstructed from the converged v28 data in the local interval $0.885 \leq X_c \leq 0.92$. A cubic fit gives

$$X_{c,\star} = 0.9052492489, \quad \varepsilon_{c,\star} = 1.2120324954.$$

Changing the local window and polynomial order across the stated robustness checks moves the extremum within the envelope printed in Chapter 15.

Declaration

Pierre Benaros is the sole author and assumes full scientific responsibility for the postulates, calculations, selections, interpretations and claims of this work. The reproducibility statements above describe the numerical and algebraic checks actually carried by the corpus; they are not a substitute for independent external reproduction or peer review.

STATUS - Version record before public deposit

This file is **RM Pillar I / Book I v5.3.0**, prepared on 23 September 2026 from the v5.2.0 line. It receives the current bulk v4.0.0 thermal/redshift hierarchy and the Off-Center Cosmography v5.1.0 formation-cost concordance without altering the frozen v28 stellar data or the N-OPT-01 theorem. The Pillar I Zenodo lineage remains DOI [10.5281/zenodo.22674666](https://doi.org/10.5281/zenodo.22674666); publication metadata must be updated only when the author deposits this revision.

Simplex sigillum veri.

The simple is the seal of the true - and the reproducible is the price of the claim.