

Constitutive Exclusion and Homogeneous Bulk Closure in Relativity of Matter

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The Conicus3D weak-lensing forward model of Zhao, Scognamiglio, Doré, and Bouman is used only as an external benchmark for the cosmological lift of Relativity of Matter (RM); none of its background equations is imported into RM. A provisional homogeneous relation, HCR-1, had been isolated with the explicit requirement that it be derived from the common action or rejected. The Version-5 calculation performs that test. On the homogeneous Fourier mode $k_F = 0$, the rate-determining elliptic cadence operator of the frozen local branch loses rank, but the algebraic Hamiltonian and conformal scalar constraints survive. With a generic constitutive reservoir $\varepsilon_z(e)$, invariant background density u_0 , and no added kinetic trace term, the reduced branch obeys GHC-1, GEC-1 and

$$H [3B'(e) + 3\rho_m + 8u_\gamma] = s, \quad B(e) = 2\varepsilon_z + 3\varepsilon'_z.$$

Revision v4.0.0 clarifies the physical interpretation of this result. In the active stellar application, the primary constitutive loading of State AE is thermal-radiative rather than an accumulated redshift-energy stock. With $u_\gamma = a_R \Theta^4$, a thermal constitutive reservoir $\varepsilon_{\text{AE}}^{\text{th}}(e)$ and a curvature-Exclusion energy $U(X)$, preservation of the corrected homogeneous constraint gives the conditional extension

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

which reduces to HBR-1 when $U = 0$. The Maria construction supplies a conditional upper thermal load; the identification of approach to that limit with an EM $\rightarrow$ AE channel change is retained only as a working bridge until a microscopic conversion law is derived. Redshift remains a genuine propagation observable and may contribute secondarily to the continuum energy ledger, but no fixed share is assigned and no redshift term is used to force the bulk closure. Boundary production remains an inhomogeneous $k_F \neq 0$ problem. The result is therefore a homogeneous closure with an explicitly separated thermal interpretation, not a completed cosmology, stellar model, or observational validation of RM.

I. INTRODUCTION: THE COSMOLOGICAL DEBT EXPOSED BY CONICUS3D

The immediate origin of the present calculation is the cosmological projection used by Conicus3D. The weak-lensing forward model of Zhao *et al.* [4] separates a local angular response from a line-of-sight projection that presupposes a background expansion and structure-growth history. For standard cosmology that background is supplied by the usual cosmological dynamics. For Relativity of Matter (RM), however, simply importing the same background would make the comparison circular: the theory would be borrowing the very homogeneous evolution law that it is supposed to derive for itself.

This exposed one of the sharpest internal weaknesses of the pre-Version-5 RM cosmological sector. The frozen local action contained no independently derived homogeneous bulk law fixing the rate H . Version 4 therefore isolated a provisional relation, HCR-1, and placed it under an explicit kill condition: derive it from the common action or reject it. The present work performs that test. HCR-1 is not recovered and is retired.

The replacement is stronger and more constrained. On the homogeneous Fourier mode $k_F = 0$, the rate-determining elliptic cadence operator loses rank, but the

algebraic Hamiltonian and conformal scalar constraints survive. Their preservation under the declared cold-matter/radiation ledger yields

$$\boxed{H [3B'(e) + 3\rho_m + 8u_\gamma] = s}, \quad (1)$$

with no imported Friedmann equation, no H_0 or Ω_m input, no external equation of state, and no additional fitted dynamical response coefficient. The Hamiltonian constraint is then preserved identically. In that precise sense, the former absence of an internally derived homogeneous bulk rate is no longer an open debt of the Version-5 branch.

The distinction is structural rather than observational. A larger or more sensitive telescope can constrain a cosmological background once an evolution law has been specified; it cannot derive a missing evolution equation from an action. Conicus3D was therefore valuable here not because it supplied RM with a cosmology, but because it exposed exactly where RM still depended on one. The calculation below removes that dependence at homogeneous bulk level.

This statement must not be enlarged beyond its domain. Version 5 does not remove the Friedmann equation from standard cosmology or from the Conicus3D analysis; it removes the need to import a Friedmann equation into the RM homogeneous bulk closure. Nor does Eq. (1) complete the RM cosmological background. The total

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manifested-volume rate is

$$H_{\text{AE}} = H + g_{\partial}, \quad (2)$$

and g_{∂} belongs to a distinct inhomogeneous boundary-production problem. The open cosmological debt has therefore moved: it is no longer the absence of a bulk law for H , but the derivation of the boundary contribution, the perturbative lift, and the resulting distance-redshift and structure-growth operators.

Cosmological and stellar redshift remain genuine propagation observables in the RM architecture. General relativity preserves local covariant stress-energy conservation, while a generic cosmological spacetime need not possess a global timelike Killing vector and therefore need not admit a unique globally conserved energy of the usual stationary type. Quasilocal constructions provide one way to formulate gravitational energy balance in finite regions [1, 2]; recent work has applied the Brown–York framework directly to cosmological redshift [3]. The present paper does not claim that standard relativistic cosmology violates local energy conservation and does not attempt to replace those quasilocal constructions.

a. Physical hierarchy in revision v4.0.0. The active RM reading is no longer that redshift supplies the primary constitutive energy sustaining the State-AE response. In the stellar application the primary proposed loading is thermal–radiative. Redshift is retained as a real propagation effect and as a possible secondary contribution to the continuum energy ledger. Its sign, receiver term and quantitative share are not derived here; in particular, no fixed percentage is inserted into the equations. This hierarchy is interpretive and does not alter the derivation of Eq. (1).

II. RETIREMENT OF THE PROVISIONAL HOMOGENEOUS RELATION

The earlier provisional branch introduced

$$\frac{H}{H_{\text{AE}}} = \frac{p_{\text{AE}} - \varepsilon_z}{\varepsilon'_z} \quad (3)$$

as a constitutive relation to be derived from the common action or rejected. The homogeneous action does not reproduce this relation. It is therefore retired rather than recalibrated. The Exclusion barrier itself is retained, but its role changes: it enters an algebraic conformal-equilibrium constraint whose tangent stiffness controls the response to a changing material–radiative load.

The homogeneous mode is denoted by $k_F = 0$, where k_F is a Fourier wave number. This notation does not assert vanishing spatial curvature; the homogeneous bulk may have ${}^{(3)}R \neq 0$.

III. CONICUS3D REMAINS AN EXTERNAL BENCHMARK

The Conicus3D forward model of Zhao *et al.* [4] separates the cosmological projection $\mathbf{Q}$ from the angular weak-lensing operator $\mathbf{P}$,

$$e_{\text{obs}} = \mathbf{P}\mathbf{Q}\delta + \varepsilon. \quad (4)$$

The projection $\mathbf{Q}$ contains a definite background and structure-growth history. RM does not import that history. The useful separation remains

$$\begin{array}{ccc} \boxed{\text{local optical response}} & \longrightarrow & \boxed{\text{RM cosmological lift}} \\ & & \longrightarrow \boxed{\text{angular operator}}. \end{array}$$

Earlier calculations established the local non-regression result and the removability of a homogeneous cadence factor from the frozen local gravity-plus-matter action. The present work addresses only the previously open homogeneous bulk step. Conicus3D is therefore a consistency benchmark and eventual discriminator, not a dynamical prior.

IV. FROZEN RM INPUT AND THE HOMOGENEOUS RANK CHANGE

The current two-derivative local gravitational branch of Pillar II [6] is

$$S_g = P \int dT d^3x \sqrt{g} \left[\frac{1}{4Nc_{\text{AE}}^2} \left(\mathcal{K}_{ij}\mathcal{K}^{ij} - \frac{1}{3}\mathcal{K}^2 \right) + N {}^{(3)}R[g] \right], \quad (5)$$

with

$$\mathcal{K}_{ij} = \partial_T g_{ij} - 2D_{(i}B_{j)}, \quad P = \frac{c_{\text{AE}}^4}{16\pi G}. \quad (6)$$

The same cadence field enters the universal matter interface through

$$\mathcal{D}_T = \frac{1}{N}(\partial_T - \mathcal{L}_B).$$

The frozen canonical scalar constraints may be written

$$\mathcal{H}_0 = \frac{c_{\text{AE}}^2}{P\sqrt{g}}\pi^{ij}\pi_{ij} - P\sqrt{g} {}^{(3)}R + \mathcal{H}_m \approx 0, \quad (7)$$

$$\begin{aligned} \mathcal{C} &= \frac{3}{2}N \frac{c_{\text{AE}}^2}{P\sqrt{g}}\pi^{ij}\pi_{ij} + \frac{P}{2}N\sqrt{g} {}^{(3)}R \\ &\quad - 2P\sqrt{g} D^2N + \mathcal{C}_m \approx 0. \end{aligned} \quad (8)$$

On the homogeneous isotropic mode,

$$\pi_{\text{TF}}^{ij} = 0, \quad D^2N_0 = 0.$$

Hence the derivative operator that fixes the local cadence loses rank, while the algebraic parts of both scalar constraints remain. The loss of rank therefore removes a rate-determining local equation; it does not erase the zero-mode constraints.

Domain rule. $k_F = 0$ denotes the **homogeneous Fourier mode, not spatial flatness.** The homogeneous bulk may have $^{(3)}R \neq 0$.

V. HOMOGENEOUS CONSTITUTIVE SECTOR

Let the already manifested bulk be described by

$$g_{ij} = a^2 \gamma_{ij}, \quad H = \frac{\dot{a}}{a}, \quad \dot{e} = 3H. \quad (9)$$

A relabelling-safe definition is

$$e \equiv \ln \left(\frac{V_{\text{el}}}{V_{\text{el, ref}}} \right) \quad (10)$$

for a material element at fixed labels; $e = 3 \ln(a/a_{\text{ref}})$ is its homogeneous coordinate expression.

The constitutive Exclusion reservoir is

$$\boxed{\varepsilon_z(e) = \kappa \frac{e}{e_{\text{cap}} - e}, \quad \kappa > 0, \quad 0 \leq e < e_{\text{cap}}.} \quad (11)$$

Write $\Delta = e_{\text{cap}} - e$. Then

$$\varepsilon'_z = \kappa \frac{e_{\text{cap}}}{\Delta^2}, \quad \varepsilon''_z = 2\kappa \frac{e_{\text{cap}}}{\Delta^3}. \quad (12)$$

The zero-mode constitutive functional is

$$S_z = - \int dT N_0 V \varepsilon_z(e). \quad (13)$$

No $\dot{e}^2$ term is added. The trace mode has no independent kinetic term in the frozen branch, so adding one would introduce precisely the free coefficient that the present audit is intended to avoid.

At fixed material labels, $dV/V = de$, and therefore the associated homogeneous pressure is

$$\boxed{\rho_z = \varepsilon_z, \quad p_z = - \frac{d(V\varepsilon_z)}{dV} = -(\varepsilon_z + \varepsilon'_z).} \quad (14)$$

Thus the reservoir is tensile, $p_z < 0$. This is the sign result that invalidates the compressive-pressure interpretation used provisionally in HCR-1.

a. Interpretive status of ε_z . In the reduced Version-5 theorem, $\varepsilon_z(e)$ is a generic homogeneous constitutive reservoir. Revision v4.0.0 does not reinterpret it as accumulated redshift energy. In the active stellar thermal application the corresponding constitutive quantity is denoted $\varepsilon_{\text{AE}}^{\text{th}}(e)$. The two notations are kept distinct so that the reduced theorem remains reproducible while the thermal completion is not smuggled into equations that did not derive it.

VI. INVARIANT STATE-Æ BACKGROUND

Pillar II [6] separates the local relational state from the homogeneous fundamental density u_0 and states that the latter is not locally stretched by an orbit and obeys $\dot{u}_0 = 0$ in the present architecture. The present calculation uses that existing background; it does not introduce a new compensator.

For a homogeneous dilation at fixed u_0 ,

$$p_0 = - \frac{d(Vu_0)}{dV} = -u_0. \quad (15)$$

Hence the active gravitational combination of the invariant background is

$$u_0 + 3p_0 = -2u_0.$$

This is a background tension carried by a positive density, not a negative-energy fluid.

VII. GHC-1: SURVIVING HOMOGENEOUS HAMILTONIAN CONSTRAINT

The homogeneous Hamiltonian may be written, up to the separate boundary sector,

$$H_G = N_0 V \left[\rho_m + u_\gamma + \varepsilon_z(e) + u_0 - P^{(3)}R \right] + \mu \pi_a. \quad (16)$$

The trace momentum obeys $\pi_a \approx 0$ because the isotropic kinetic combination in Eq. (5) vanishes identically. Variation with respect to N_0 gives

$$\boxed{P^{(3)}R = \rho_m + u_\gamma + \varepsilon_z(e) + u_0} \quad (\text{GHC-1})$$

No H^2 term occurs. GHC-1 is an algebraic bulk constraint between intrinsic curvature and the homogeneous content.

The term $-P^{(3)}R$ is the existing curvature contribution to the Hamiltonian constraint. The present calculation does *not* reinterpret it as a new material substance or an external reservoir. Its time variation supplies the compensating geometric term required by preservation of the local constraint balance.

VIII. GEC-1: CONFORMAL EQUILIBRIUM CONSTRAINT

Preservation of $\pi_a \approx 0$, equivalently the homogeneous conformal scalar constraint, gives

$$P^{(3)}R + 3p_{\text{tot}} = 0, \quad (17)$$

with

$$\begin{aligned} p_m &= 0, & p_\gamma &= \frac{1}{3}u_\gamma, \\ p_z &= -(\varepsilon_z + \varepsilon'_z), & p_0 &= -u_0. \end{aligned}$$

Combining Eq. (17) with GHC-1 yields

$$\boxed{\rho_m + 2u_\gamma - 2u_0 = 2\varepsilon_z(e) + 3\varepsilon'_z(e)} \quad (\text{GEC-1})$$

Define

$$B(e) \equiv 2\varepsilon_z(e) + 3\varepsilon'_z(e). \quad (18)$$

For Eq. (11),

$$B'(e) = 2\varepsilon'_z(e) + 3\varepsilon''_z(e) = 2\kappa \frac{e_{\text{cap}}}{\Delta^2} + 6\kappa \frac{e_{\text{cap}}}{\Delta^3} > 0. \quad (19)$$

Furthermore

$$B(0) = \frac{3\kappa}{e_{\text{cap}}}, \quad B(e) \rightarrow +\infty \quad (e \rightarrow e_{\text{cap}}^-).$$

Therefore, whenever

$$\boxed{\rho_m + 2u_\gamma - 2u_0 \geq \frac{3\kappa}{e_{\text{cap}}}}, \quad (20)$$

there exists one and only one solution $e_{\text{eq}} \in [0, e_{\text{cap}})$ of GEC-1.

LF-09 on the homogeneous branch. The branch is not stopped at the capacity by an imposed rule. The conformal constraint selects at most one admissible state below the capacity, and the branch ceases to exist if its algebraic existence condition fails.

IX. HBR-1: DERIVED HOMOGENEOUS BULK RATE

The rate is obtained by preserving GEC-1, not by introducing a new expansion equation. Let s be the local matter-to-radiation conversion rate per unit volume. For cold matter and isotropic radiation in the homogeneous bulk,

$$\begin{aligned} \dot{\rho}_m &= -3H\rho_m - s, & \dot{u}_\gamma &= -4Hu_\gamma + s, \\ \dot{u}_0 &= 0, & \dot{e} &= 3H. \end{aligned} \quad (21)$$

Differentiating GEC-1 gives

$$3HB'(e) = -3H\rho_m - 8Hu_\gamma + s,$$

and therefore

$$\boxed{H[3B'(e) + 3\rho_m + 8u_\gamma] = s} \quad (\text{HBR-1})$$

Since $B' > 0$, $\rho_m \geq 0$ and $u_\gamma \geq 0$, the denominator is strictly positive on the regular branch:

$$\boxed{H = \frac{s}{3B'(e) + 3\rho_m + 8u_\gamma}}. \quad (22)$$

Thus

$$s > 0 \Rightarrow H > 0, \quad s = 0 \Rightarrow H = 0,$$

within the assumptions of the homogeneous bulk ledger.

This result replaces the provisional relaxation law. There is no independent relaxation time for e at this order: e is algebraically constrained by GEC-1, and its time dependence follows from the time dependence of the load.

A. Preservation of GHC-1

For the conformal bulk flow, $\dot{R} = -2HR$. Differentiating the right-hand side of GHC-1 using Eq. (21) gives

$$\begin{aligned} \frac{d}{dT}(\rho_m + u_\gamma + \varepsilon_z + u_0) &= -3H\rho_m - 4Hu_\gamma + 3H\varepsilon'_z \\ &= -2H(\rho_m + u_\gamma + \varepsilon_z + u_0), \end{aligned} \quad (23)$$

where the second line is exactly GEC-1. Hence

$$P\dot{R} = -2HPR$$

and GHC-1 is preserved identically. The two scalar constraints are therefore mutually consistent; no additional homogeneous rate equation appears.

X. THERMAL-RADIATIVE COMPLETION AND THE MARIA LIMIT

The reduced system above is the exact Version-5 homogeneous theorem under its stated ledger. The thermal correction adopted in the current Book V synthesis [8] requires one additional distinction: the constitutive loading attributed to State AE is primarily thermal-radiative, while redshift is not promoted to the role of dominant source.

For an equilibrium photon sector with two polarizations and vanishing chemical potential,

$$\boxed{u_\gamma = a_R \Theta^4, \quad a_R = \frac{\pi^2 k_B^4}{15 \hbar^3 c_{\text{AE}}^3}}. \quad (25)$$

The thermal constitutive reservoir is denoted $\varepsilon_{\text{AE}}^{\text{th}}(e)$. The curvature-Exclusion sector is represented, on the same homogeneous reduction, by

$$\begin{aligned} X &= \frac{\ell_\star^4 R^2}{3}, \quad 0 \leq X < 1, \\ U(X) &= u_\star F(X), \quad F(X) = 1 - \sqrt{1 - X} - \frac{X}{2}. \end{aligned} \quad (26)$$

Here primes on $\varepsilon_{\text{AE}}^{\text{th}}$ denote derivatives with respect to e , while primes on U denote derivatives with respect to X .

Under the homogeneous assumptions of the Maria reduction, the corrected Hamiltonian and conformal constraints are

$$P^{(3)}R = \rho_m + u_\gamma + \varepsilon_{\text{AE}}^{\text{th}} + u_0 + U, \quad (27)$$

$$\rho_m + 2u_\gamma - 2u_0 = 2\varepsilon_{\text{AE}}^{\text{th}} + 3(\varepsilon_{\text{AE}}^{\text{th}})' + 2U - 4XU'. \quad (28)$$

These equations are a homogeneous reduction. They are not a pointwise stellar field equation, and they do not by themselves supply the stellar transport law or equation of state.

Define

$$B_{\text{th}}(e) = 2\varepsilon_{\text{AE}}^{\text{th}}(e) + 3(\varepsilon_{\text{AE}}^{\text{th}})'(e). \quad (29)$$

For the same matter-to-radiation ledger used in HBR-1, with $\dot{X} = -4HX$, preservation of Eq. (28) gives

$$\boxed{H \left[3B'_{\text{th}}(e) + 8XU'(X) + 16X^2U''(X) + 3\rho_m + 8u_\gamma \right] = s} \quad (30)$$

For $U = 0$ this reduces to HBR-1. Equation (30) is therefore an extension under additional thermal/curvature assumptions, not a retroactive replacement of the reduced theorem.

A. Maria bound and UC-1 status

The Maria construction is a capacity calculation, not a temperature fit. Under the working capacity postulate

$$\boxed{u_{\text{AE}}^{\text{cap}} = \frac{P}{\ell_\star^2}} \quad (\text{UC-1}), \quad (31)$$

and the corresponding normalization $u_\star = 2P/\ell_\star^2$, the homogeneous reduction gives the conditional upper thermal load

$$\boxed{\Theta \leq \Theta_{M,\text{sup}} = \left[\frac{1}{a_R} \left(\frac{5P}{4\ell_\star^2} - u_0 \right) \right]^{1/4}}, \quad (32)$$

when the argument is non-negative. No universal numerical temperature in kelvins follows until $\ell_\star$ is fixed independently. The bound lies below the geometric capacity in this reduction; the two limits are not the same object.

Status of the thermal threshold bridge. Equation (32) is a conditional constitutive bound. The further statement that approach to the admissible thermal limit closes the radiative/thermal channel and selects EM→AE as the outgoing state-change channel is a working RM bridge motivated by LF-09, not a microscopic theorem of the present paper. Its conversion law, efficiency, entropy production and actual attainment in an inhomogeneous star remain open.

B. Redshift is retained, but not assigned a fictitious share

Revision v4.0.0 does not set the redshift contribution to zero. A stellar or cosmological redshift remains a real propagation effect, and a complete future energy ledger may contain a redshift-related continuum-work term. What is removed is the stronger identification of that term as the primary source of the constitutive State-AE loading. No coefficient such as “92/8” is introduced: the thermal channel is treated as primary in the active physical reading, the redshift channel as potentially secondary, and their quantitative partition is left to a derivation that can fail.

XI. THE CORRECTED ENERGY READING

A previous audit temporarily treated radiative transfer from the bulk to the boundary as if it were an export from the complete manifested domain. That is incorrect. The physical control volume matters.

For an old homogeneous bulk element at fixed labels, the curvature term in GHC-1 supplies the geometric work required by preservation of the constraint. The relevant statement is not that energy leaves the Universe, but that exchanges between content and the existing relational-curvature term are internal to the manifested system.

The active interpretation now separates three ledgers that earlier versions mixed too easily:

1. the **thermal-radiative load**, represented by $u_\gamma = a_R\Theta^4$ and, in the stellar application, by the constitutive reservoir $\varepsilon_{\text{AE}}^{\text{th}}$;
2. the **propagation/redshift sector**, which remains physically real but whose contribution to continuum work is not quantitatively derived here;
3. the **boundary-production sector**, in which a non-zero radiative flux and EM→AE conversion determine g_∂ through their own inhomogeneous laws.

The historical notation P_z/W_z is therefore not used as an active source law in revision v4.0.0. This does not assert $P_z = 0$. It asserts only that no redshift-energy stock is inserted by hand into GHC-1, GEC-1, Eq. (30), or the stellar support interpretation. If a future derivation identifies a non-zero redshift-related transfer, it must enter a complete ledger with a specified receiver term and with the opposite sign in the sector that receives the energy. Its magnitude must be calculated rather than chosen to preserve a preferred conclusion.

Ledger rule. Thermal loading is primary in the active stellar interpretation; redshift remains a possible secondary contribution. Neither channel is assigned a fitted percentage in this manuscript.

XII. BOUNDARY PRODUCTION IS A SEPARATE $k_F \neq 0$ SECTOR

The total manifested-volume ledger remains

$$H_{\text{AE}} = H + g_{\partial}, \quad g_{\partial} = \frac{\Gamma_{\partial}}{3V_{\text{AE}}}. \quad (33)$$

The present calculation does not set $g_{\partial} = 0$. It instead separates the two physical problems.

In a homogeneous isotropic bulk, the net radiative flux vector vanishes by isotropy. A non-zero outward photon flux and the EM $\rightarrow$ AE conversion therefore live in a boundary layer with gradients, hence in an inhomogeneous sector. The reduced equations GHC-1, GEC-1 and HBR-1 describe the deep homogeneous branch, while Eqs. (27)–(30) describe its conditional thermal completion. The boundary layer determines g_{∂} through its own transport and conversion laws. In the active working bridge, approach to the Maria thermal limit is a candidate trigger for channel closure under LF-09; that trigger is not derived by the present homogeneous calculation.

The current boundary ledger is retained as a conditional target,

$$\mathcal{U}_{\partial}\Gamma_{\partial} = \mathcal{P}_{\gamma,\partial}, \quad \mathcal{U}_{\partial} = \frac{P}{\ell_{\star}^2}, \quad (34)$$

but the present calculation does not identify the formation cost $\mathcal{U}_{\partial}$ with the residual energy density u_{birth} of the newly manifested volume. That distinction belongs to the boundary derivation.

For a growing domain, the volume-averaged curvature need not obey the fixed-label law. If newly produced volume has curvature R_N , then for $\bar{R} = V^{-1} \int R dV$ the production contribution is

$$\boxed{\Xi_{\partial} = 3g_{\partial}(R_N - \bar{R})}, \quad (35)$$

under the homogeneous-shell bookkeeping used here. This affects the global average, not the pointwise bulk constraint. It is another reason not to insert boundary production into the $k_F = 0$ bulk equation by hand.

XIII. SUPERSESSON OF THE PROVISIONAL HCR-1 BRANCH

The earlier provisional branch obtained a stable sub-capacity attractor only conditionally on HCR-1. The present action-level calculation performs the required test and obtains a different structure. In particular, HCR-1 is retired; the provisional compressive load is replaced by the derived tensile reservoir pressure $p_z = -(\varepsilon_z + \varepsilon'_z)$; the sub-capacity state is selected by GEC-1 rather than by $p_{\text{AE}} = \varepsilon_z$; no independent zero-mode relaxation time is introduced; and the interior rate H is fixed by HBR-1 while g_{∂} belongs to the boundary sector. The capacity is therefore excluded by algebraic existence on the regular

branch rather than by a separately postulated relaxation dynamics.

The provisional calculation isolated the exact object that had to be derived. The present derivation replaces that object instead of adjusting it.

XIV. SCOPE OF THE HOMOGENEOUS CLOSURE

The reduced Version-5 homogeneous bulk system is

$$P^{(3)}R = \rho_m + u_{\gamma} + \varepsilon_z(e) + u_0, \quad (36a)$$

$$\rho_m + 2u_{\gamma} - 2u_0 = 2\varepsilon_z(e) + 3\varepsilon'_z(e), \quad (36b)$$

$$H[3B'(e) + 3\rho_m + 8u_{\gamma}] = s, \quad (36c)$$

$$\dot{e} = 3H, \quad (36d)$$

$$H_{\text{AE}} = H + g_{\partial}. \quad (36e)$$

Equations (36a)–(36d) close the reduced homogeneous bulk once the local source s and the constitutive parameters of ε_z are specified. Equation (36e) is the exact volume decomposition; g_{∂} is not supplied by the bulk and must be obtained from the boundary sector.

The active thermal interpretation adds Eqs. (27), (28) and (30) under their additional assumptions. These equations do not erase the reduced theorem; they specify the branch in which thermal/radiative loading and the curvature-Exclusion energy $U(X)$ are retained explicitly.

No Friedmann equation, H_0 , Ω_m , external equation of state or fitted response coefficient is used to obtain either the reduced closure or its stated thermal extension.

XV. OPEN SECTORS AND FALSIFICATION CONDITIONS

The following sectors remain outside the present closure:

1. **Thermal transport and conversion.** Derive the transfer law Q , the non-radiative entropy terms, conversion entropy production and the boundary conditions needed to turn the Maria bound into a dynamical stellar transport problem.
2. **Maria threshold bridge.** Derive, falsify or replace the working identification between approach to the admissible thermal limit, LF-09 channel closure and the microscopic EM $\rightarrow$ AE transition. The bound alone does not prove that the transition occurs or that the equality is attained.
3. **Secondary redshift channel.** Determine whether redshift contributes non-zero continuum work beyond its role as a propagation observable and, if so, derive its sign, receiver term and quantitative share. No percentage is fitted in advance.

4. **Boundary layer.** Derive the $k_F \neq 0$ conversion layer, its radiative transport Φ_∂ , its curvature gradient, and the resulting g_∂ .
5. **Formation cost versus birth density.** Determine whether $\mathcal{U}_\partial$ is a transient conversion cost, a residual density, or partly routed to another state; do not set $\mathcal{U}_\partial = u_{\text{birth}}$ without derivation.
6. **Constitutive scales.** Derive or independently anchor κ , e_{cap} and ℓ_* ; they may not be fitted solely to reproduce an external expansion history or a desired temperature.
7. **Perturbations and lensing lift.** Derive the $k_F \neq 0$ cosmological perturbation equations and the RM distance/redshift and structure-growth operators before returning to Conicus3D as a discriminator.

The homogeneous bulk branch is falsified or replaced if any of the following occurs:

1. a complete derivation of the frozen action shows that either GHC-1 or GEC-1 has an omitted homogeneous term;
2. the invariant background u_0 does not enter the homogeneous interface with $p_0 = -u_0$ under the declared Pillar-II architecture;
3. the physical load violates Eq. (20), so no admissible $e < e_{\text{cap}}$ exists;
4. the boundary theory requires a modification of the bulk constraints rather than a separate inhomogeneous matching problem;
5. an additional free dynamical coefficient is required only to reproduce a chosen external cosmological curve.

XVI. RETURN PATH TO THE CONICUS3D BENCHMARK

The local optical response remains a non-regression result, and the homogeneous bulk is no longer represented by a provisional HCR-1. The remaining route to an observational comparison is now

homogeneous bulk closure $\longrightarrow$ boundary production
 $\longrightarrow H_{\text{AE}}(T)$
 $\longrightarrow$ perturbation/growth lift
 $\longrightarrow$ Conicus3D benchmark.

Conicus3D becomes a genuine discriminator only after the boundary and perturbative sectors are derived internally. If a standard distance-redshift relation is recovered later, it must emerge after the RM derivation rather than being imposed as a selection criterion.

XVII. CONCLUSION

The provisional branch was placed under a kill condition: derive HCR-1 or reject it. The Version-5 calculation rejects HCR-1 and retains the homogeneous sector through a different result.

On the homogeneous Fourier mode, the derivative cadence operator loses rank but the algebraic Hamiltonian and conformal scalar constraints survive. With the specified generic constitutive reservoir $\varepsilon_z(e)$ and invariant background u_0 , they give GHC-1 and GEC-1. For the Exclusion barrier, GEC-1 has at most one admissible sub-capacity solution and supplies an explicit existence threshold. Preserving that constraint yields the reduced bulk-rate relation HBR-1,

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

while GHC-1 is then preserved identically.

Revision v4.0.0 repairs the physical energy hierarchy without rewriting that theorem. In the active stellar interpretation, the primary proposed loading of State AE is thermal-radiative. With $u_\gamma = a_R \Theta^4$, the thermal reservoir $\varepsilon_{\text{AE}}^{\text{th}}$ and the curvature-Exclusion term $U(X)$, constraint preservation gives the conditional extension Eq. (30). The Maria construction supplies the conditional bound Eq. (32). The further identification of approach to that bound with LF-09 channel closure and EM $\rightarrow$ AE conversion remains a working bridge until the microscopic transport and phase-change law are derived.

Redshift is not deleted. It remains a genuine propagation observable and may contribute secondarily to a complete continuum energy ledger. What is withdrawn is the stronger claim that an accumulated redshift-energy stock is the primary source of the constitutive support. No numerical partition between thermal and redshift channels is assumed.

The homogeneous bulk therefore closes without an imported Friedmann equation, without an external energy reservoir and without a new fitted dynamical coefficient. Boundary production is neither set to zero nor derived by this theorem. It belongs to the inhomogeneous conversion layer and remains a separate calculation needed to determine the total manifested-volume rate $H_{\text{AE}} = H + g_\partial$.

This is the precise claim of revision v4.0.0: the homogeneous Hamiltonian debt remains closed at bulk level; the thermal hierarchy is made explicit; the redshift channel is demoted rather than erased; and the Maria-to-EM $\rightarrow$ AE bridge is exposed as an open microscopic problem rather than hidden inside the bulk ledger.

DATA AVAILABILITY

No new empirical data were generated or analyzed in this work. All equations needed to reproduce the analytic derivation are contained in the article. A companion

account of the homogeneous result is given in the Version-5 technical note [9].

AI ASSISTANCE AND VERIFICATION

OpenAI ChatGPT (GPT-5.6 Sol, accessed September 2026) was used for algebraic cross-checking, adversarial criticism, manuscript restructuring, and LaTeX production. Anthropic Claude, accessed through the web application in September 2026, was used for independent adversarial-audit passes; the exact Claude model identifier was not preserved in the retained session transcript. The author directed the questions and acceptance/rejection criteria, reviewed the resulting algebraic chains, and retained only claims that could be reproduced from the stated equations. These checks are not external peer review or observational validation.

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Pierre Benaros is the sole author and assumes full responsibility for all assumptions, calculations, interpretations, and claims. AI assistants were used for algebraic cross-checking, critical review, manuscript restructuring, and LaTeX preparation, as detailed above.

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