Apeiron: A Bounded Scientific-Feasibility Construction for a Fundamental Cosmological Carrier

Josip Fellner · Independent Researcher ORCID: https://orcid.org/0009-0003-1705-3985 · Correspondence: info@apeironfield.com **Publication version 2.0 · 15 September 2026 · Scientific cutoff: audited checkpoint 060** Venue-neutral preprint. Prepared release; no new deposit, peer review or empirical validation is claimed.

Abstract

Apeiron proposes one fundamental carrier whose states and organizations could underlie effective spacetime and matter descriptions. This article consolidates a bounded mathematical and physical feasibility result for one local realization, Variant B, and its uniquely named witness O049. The inherited construction supplies a common smooth homogeneous solution, a correlated renormalized source and state binding, admissible local dynamics, and a qualitative causal scalar and transverse-traceless response with a finite local stability bound. Its common feasibility domain is conformal time $\eta \in [-1/125, 0]$ and wave number $k \in [5/8, 5/4]$. For the narrower non-flat θ-source problem at $k = 1$, a compatible initial-state variation cancels the first correlated portal initial logarithm, and the specified once-Duhamel-corrected source Ward test satisfies its frozen budgets. These results support SCIENTIFIC FEASIBILITY GO under the explicitly documented local criteria. They do not complete AP1_GO. Audits 058-060 leave the full quantitative raw/paired-data response undecided: the required executable O049 histories, transports, complete contact assembly, uniform operator errors, reference calculation and finite cost bound are not jointly available. The single-time reformulation is algebraically established at a common finite regulator, but is not production-ready. No full response calculation or new physical NONPASS is reported. The carrier ontology, global cosmology and observational predictions remain outside the established result.

Keywords: semiclassical response; local feasibility; compatible initial data; Ward identity; O049; reproducibility; bounded cosmological construction

1. Question and evidential scope

The scientific question addressed here is whether a particular realization of Apeiron admits the stated local mathematical and physical construction. It is not whether a fundamental carrier has been observed or whether all cosmological phenomena have been derived from it. The single-carrier proposal motivates the model; the evidence concerns a specific source prescription, a specific state and a bounded domain.

The distinction matters because several different accomplishments occur in the same research program. A state can have an exact mathematical definition without an affordable numerical evaluator. A causal response can exist as a distribution without all its matrix elements having been computed. A Ward contraction can meet its quantitative budget without fixing the complete

response. This paper keeps those accomplishments separate.

The authoritative scientific endpoint is the reviewed closure of checkpoint 060 on 15 September 2026. Reviews 058 and 059 identify the inherited positive findings and the unresolved evaluator; review 060 assesses the proposed single-time route and its cost contract. Earlier technical statements are used only in the scope carried forward by these reviews. Higher branch numbers do not supersede this explicitly selected endpoint. [E01-E05]

No physical production calculation was performed in preparing this publication. Statements about existing mathematics and stored numerical bounds are consolidations of the cited records. The publication checks file integrity, source attribution and cross-document consistency; it does not claim a new independent derivation of the entire proof chain.

1.1 Status at the scientific cutoff

Item	Status	Meaning
SCIENTIFIC FEASIBILITY GO	TRUE	Local, author-defined criteria inherited from 054
AP1_GO	FALSE	Formal AP1 completion has not been established
Corrected θ-source Ward test	PASS	Specified paired-data source channel, k = 1
Complete quantitative response	RAW_RESPONSE_EVALUATOR_METHOD_LIMIT	Undecided; no full production result
SINGLE_TIME_ROUTE_READY	FALSE	No complete, decision-capable cost-bounded route
New physical NONPASS in 060	Not established	Method limitation does not exclude the witness

The term SCIENTIFIC FEASIBILITY GO is the publication label for the existing local FEASIBILITY_GO. It does not redefine the stronger AP1_GO decision. [E03, E04, E09]

2. Variant B: the physical object being assessed

2.1 Effective variables and correlated source

The construction uses a spatially flat homogeneous background with scale factor a, effective fields σ and θ, and a portal field χ. Write $h = m\chi^2(\sigma, \theta)$. The portal operator is $P\chi = -\Box + h$. These effective variables specify the local realization; their number is not a count of fundamental constituents of the proposed carrier. The original response specification fixes the portal coupling and requires coupled metric and field variations. [E21, E23]

Variant B uses Q_target as its physical source. Its difference from an alternative source, $\Delta_{alt} = Q_{alt} - Q_{target}$, is retained only as a comparison. Adding that difference back into B would change the model. In the direct covariant construction, the source is the correlated operation

```
Q_B = Q_Had[S; g, h] + Q_Ward/anomaly[g, h] + Q_finite[g, h].
```

S is one positive quasifree Hadamard covariance on the same smooth history. The Hadamard term, its conservation completion and the finite local terms are not independently adjustable sources. In particular, a naively differentiated subtracted two-point function is not by itself the conserved source. The complete triplet contains the quantum energy density ρ_q, pressure p_q and portal expectation C_q in the same reference convention. Its homogeneous balance is

```
dρ_q/dt + 3H(ρ_q + p_q) = (dh/dt) C_q / 2.
```

Here H is the cosmic Hubble rate. This identity is a relation within the common source prescription, not an observational fit. The full nonlocal state dependence, regulator/anomaly terms and initial/contact contributions remain part of Q_B. [E23-E25]

2.2 Finite normalization and contact accounting

The source retains the finite C016/C018 normalization and its original Einstein-Hilbert convention. In the direct covariant formulation, the finite mass and EH pieces use the bound Taylor subtractions $T_r^2(V_{PV} - V_{ref})$ and $T_r^1(U_F - U_{ref})$, with the designated M5 contribution once and the transported frozen curvature coefficients. These symbols name the inherited normalization operations; they do not introduce new coefficients. [E23]

Finite curvature choices must be distinguished from bare regulator counterterms, anomaly contributions and end terms. Setting a renormalized curvature coefficient to zero does not set all of those contributions to zero. The EH contribution and its correlated portal boundary variation are retained once. The Cauchy slice introduces no independently chosen surface energy, regulator population or new physical wall. [E23-E25]

The local source definition and its inherited conventions are fixed by the supplied technical records. This publication does not promote the older homogeneous Float64 map into a universal specification of B. The companion Canonical Model Specification gives the current operational contract and the boundary between mathematical definition and numerical availability.

3. The O049 witness and its fixed domain

3.1 Selection and exact identity

The active witness is

```
O049.L2p198.FIRST-FINITE-STRICT-RAW-CELL-1.v2.
```

Its starting prefix is L = 2^198. The V2 selector enumerates finite RAW-CELL-1 certificate attempts in the native order and chooses the first strictly certified attempt at each repair stage. For a trial indexed by a support exponent and a precision index, certification requires the designated rational intervals to be defined and finite, with strictly positive separation from the fixed inadmissible boundaries. An uncertified finite attempt is not a physical rejection of its support. [E10]

The selector defines a complete recursive covariance name. Termination of each finite repair stage is established within that construction, but a practical point evaluator of every required repair, transport and moment is not thereby supplied. The rule does not claim the absolutely smallest physically admissible repair support. After the selection freeze, the full covariance identity with the earlier O047 representation was established. This identity, rather than similarity of low moments, permits the corresponding local results to be inherited. [E10, E11, E28]

3.2 Time, state transport and response domain

Use the existing conformal Planck conventions, with the response time increasing in η. The response interval is I = [−1/125, 0]; τ = −η is an oppositely oriented coordinate. The common local feasibility statement uses k ∈ [5/8, 5/4]. The homogeneous existence and positive-expansion result has a larger stated interval 0 ≤ τ ≤ 1/10, but the joint feasibility claim uses the smaller response window. No redshift or astronomical duration is inferred from these endpoints. [E09, E12-E15]

The covariance at the earlier response slice i = −1/125 is transported from the same unperturbed O049 state at 0:

```
Σ_i(q) = T_q(i, 0) Σ_049,0(q) T_q(i, 0)^T.
```

T_q is the symplectic propagator on that same history. Both the reference covariance and the smooth state remainder are transported. Replacing the transported reference by an instantaneous vacuum would change the construction. The unperturbed anchoring operation is performed once; it is not reapplied to each perturbed history to impose a new final-state constraint. [E12]

The current non-flat response problem includes separately specified compatible initial-state data, as set out below. The early anchoring record also describes a fixed-state subproblem. That historical subproblem is not the general current baseline for arbitrary non-flat sources. [E01, E16]

4. What the local feasibility result establishes

The 054 declaration collected six criteria on the common domain. Its adoption occurred after earlier O049 results were known. The criteria were then frozen before the local GO declaration. They are not represented here as an original, result-blind definition dating from the beginning of the research program. The later reviews inherit this bounded decision; they do not re-prove its full ancestry. [E09]

4.1 Existence, regularity and common source/state binding

The inherited local construction supplies an actual smooth homogeneous fixed point at the fixed complete covariance. It retains the common initial source, nonlocal transport, correlated target jets and CCR/Hadamard/UV structure. The 049 identity transfers these results to the stated O049 witness as whole-state results. It is not a transfer of independent numerical values from a different state. [E09-E15]

The fixed point is local. No global inhomogeneous nonlinear Cauchy theorem, complete cosmological history or unique microscopic action follows from its existence.

4.2 Local dynamics and stability minimum

On the stated domain the inherited construction maintains a > 0, H > 0 and the designated kinetic admissibility conditions. The coupled scalar and transverse-traceless (TT) response, with the existing compatible initial-data class and cold M1 pilot prescription, has a finite qualitative bound of the form

```
||GI geometry/fields|| + ||physical sources||_C0
    + ||standard moments||_C0 ≤ C_0049 I_data,
C_0049 < ∞.
```

GI means gauge-invariant: the reconstructed quantities represent the physical perturbations independently of the chosen coordinate description. I_data is the prescribed compatible data norm.

The statement is finiteness of a bound; it supplies neither a numerical value of C_O049 nor a small unweighted amplification factor. It does not establish general vector response, long-time stability or all finite-frequency and parametric stability conditions. [E09, E14, E15]

The cold M1 pilot is a specified standard-sector source prescription. Qualitative statements for each actually supplied nonnegative integrable rate do not choose a rate or yield a unique observational prediction without one. The local pilot does not complete the early-to-present physical M1 connection. [E14, E15]

4.3 Ward, constraints and causal structure

The common distributional variation includes stress, portal, local and initial terms. Its inherited Ward and gauge identities lead to the specified GI projection and constraint reconstruction. The construction preserves physical retardation in increasing η. A contraction argument for a backwards homogeneous construction is not used as a replacement for the forward causal response. [E12, E14]

For initially flat bulk sources, the renormalized 6 × 6 structural variation is defined on the stated class. The compatible initial-data theorem extends the qualitative statement in its specified tangent space. Neither result is a numerical evaluation of every raw block for arbitrary initial jets. [E14, E15]

The sixth feasibility criterion is that no contradiction is demonstrated by the combined local evidence on its domain. That is a statement about the documented evidence and scope, not an unrestricted assertion of mathematical consistency. [E09]

5. Compatible initial-state response

5.1 Paired data

The non-flat θ problem uses a compatible pair consisting of a source history and an initial covariance tangent. At a common finite regulator the current decomposition is

```
δΣ_i = P_i[z] + R_i,
δΣ_c = δΣ_fixed-state + H_V[δΣ_i].
```

P_i[z] is the determined compatible prefix built from the actual three initial portal jets z. R_i is the separately given compatible remainder, with its required finite N1 norm. H_V denotes homogeneous covariance transport in the designated profile. R_i is not the smooth unperturbed state remainder used in the background construction. Nor is the decomposition a proved source-only map that produces a bounded R_i for every source. [E16, E20]

For an output vertex D_A, the first variation remains

```
δ(D_A Σ) = (δD_A)Σ + D_A δΣ.
```

The explicit vertex variation uses the unvaried full covariance. Adding (δD_A)H_V[δΣ_i] as a linear term would count second variation order. The local, initial and source-chain terms retain their original assignments. [E16]

5.2 Correlated initial logarithm

The compatible prefix has the opposite first portal initial-log coefficient to the retarded contribution. With the same regulator, the whole coefficient cancels before taking the limit and before applying an error norm. Both independent initial test-function monomials are retained. The finite conversion

$$G0_AK = G0_3D - k^2/(12\pi^2)$$

is fixed by the existing convention. It is not an adjustable initial counterterm. The cancellation does not set the six finite raw responses to zero and does not restore the former isolated non-flat fixed-state contract. [E01, E16, E17]

5.3 The determined quantitative composition

For the designated approximate θ computation, the bound composition is

$$\text{Response_A} = F056,\text{finite,A} + H_P,AK,A + DC1_A + M_A(R_i),$$
$$A = \rho,\ q,\ p,\ \pi_amp,\ J_\sigma,\ J_\theta.$$

F056,finite is the finite raw-word, source-chain, state, local and boundary assembly in the common subtraction. H_P,AK includes prefix bulk and end terms. DC1 is the specified once-Duhamel correction of that approximate prefix transport. M_A is the separate N1 remainder functional. F056,finite alone is not a newly valid isolated non-flat fixed-state kernel. [E05, E16, E20]

DC1 replaces its previous defect term by $-\delta L\ \Delta C$; the old defect is not added again. The N1 remainder channel retains V_B and does not silently acquire the corrected prefix profile. A prefix already transported exactly must not receive a second copy of the same DC1 correction. Alternative direct and Stokes expressions are representations of one functional, not separate contributions. [E05, E17, E20]

6. Quantitative θ-source Ward result

The inherited quantitative result is specifically the corrected non-flat θ-source Ward test for O049 on $\eta \in [-1/125, 0]$, $k = 1$, the original C_N^6 source/output tests, and the specified once-Duhamel-corrected computational expression. N = ln a and the tests use the original N-derivative norms. The separate remainder channel is not awarded a numerical response PASS by this result. [E01-E03, E17, E18]

The recorded inequalities are

$$N0 + B0 + 2\ HP1 \le \varepsilon = 2\ B0$$

for each of the two Ward rows WT and WL. The symbols are the frozen contributions and budgets in the DC8 record. The following display is rounded; the source record retains exact rational quantities.

Ward row	Total bound	Frozen budget	Budget used	Decision
WT	$6.4263936923 \times 10^{-7}$	$1.2381703683 \times 10^{-6}$	51.90233797%	PASS
WL	$1.7642216729 \times 10^{-12}$	$3.2415840132 \times 10^{-12}$	54.42467836%	PASS

Reviews 058 and 059 checked the stored comparisons with exact fractions. The publication reproduces that bounded result without a new Ward refinement. A pair of Ward contractions does not determine the six complete raw responses. The budgets are not the six raw-row production tolerances. The k = 1 result does not extend numerically to the entire feasibility band. [E01, E02, E18, E26]

7. Why the complete quantitative response remains open

7.1 Mathematical availability and executable availability

The AQ assembler fixes the two Wick contractions and the source measure for all 36 raw blocks. A complete two-time input requires both mode legs and the physical derivative slots 00, 01, 10 and 11. It computes integrands; it supplies neither the full O049 histories nor all integration and contact operations. The reduced θ formulas checked in 059 are algebraic identities on supplied arguments. They are not production output. [E02, E27]

Similarly, the saved O049 prefix quantities and the exact covariance name are usable information, but they do not constitute the required complete transport sampler. The affine profile evaluator returns D_A/W_A, while the designated D_B/W_B and free-source terms still lack their full central or sufficiently tight correlated evaluation. An enclosure could be sufficient in principle; it would have to cover the complete object at the required resolution. [E02-E06, E28]

7.2 What an admissible output would contain

Without an individual R_i datum, the response contract permits six source intervals plus six enclosed linear N1 functionals. It does not require inventing a physical initial tangent or setting its norm to zero or one. Individual total numbers require the corresponding actual compatible data. [E20]

The functional approximation must have a uniform weighted error bound over the full designated momentum, angular and output-test domain. In the notation of the bound contract,

```
η_A ≥ sup_g ess sup_(q,n)
      ||K_A[g] − K̃_A[g]||_nuclear / (1+q),
|(M_A − M̃_A)(R_i)| ≤ η_A N1(R_i).
```

Here η_A is an operator error radius, distinct from conformal time η; the nuclear norm is the sum of matrix singular values. A finite list of sample profiles does not establish this uniform bound. N1 alone does not license an arbitrarily small high-momentum truncation error without a suitable tail statement or retained asymptotic operator contribution. [E05, E20]

7.3 The outstanding components

Component	Present	Not completed at 060
State and history	Exact witness, prefix data, analytic profiles and bounds	Complete certified O049 coefficient/state/transport evaluation
DC1	Defined correction and Ward bound	Six central corrected pairings and full evaluation error

Component	Present	Not completed at 060
Finite parameters	Vi/AK intervals	Full numerical use and propagated parameter width
Local and initial assembly	Common counting prescription	Complete renormalized numerical sum
N1	Valid functional output contract	Numerical operator representation and uniform radii
Error and reference	Partial error maps and original norms	Complete budget, independent reference and convergence
Cost	Structural operation counts	Decision-capable finite runtime and memory bounds

The 36 historical/profile error slots, six prefix rows and six N1 coefficient rows are existing partial evidence. They are not 36 computed raw responses. An unevaluated registry term is open, not numerically zero. A large error bound or resource limit is also not a physical NONPASS. [E03-E06, E19, E29-E31]

At 060, all six stored complete response fields and the quantitative response decision are null. Null means not computed or not decided. It is never a physical zero. No complete production, reference or convergence run took place. [E04]

8. The single-time route and its limit

8.1 Algebraic result inherited from 060

At the same finite regulator, let q and p = k − q label the two legs, with canonical generators A_q, A_p and propagators T_q, T_p. In the fixed Ω_l frame, define the physical return map

```
R_l(t) = [[1/(a√Ω_l), 0],
          [−U/(a√Ω_l), √Ω_l/a]],
U = dN/dη.
```

In this subsection t and s are the conformal-time arguments of the 060 matrix formulas, not cosmic time. With the full equal-time covariance Σ_l and the unchanged CCR matrix J,

```
F_l(t,s) = R_l(t) T_l(t,s) Σ_l(s) R_l(s)^T,
Δ_l(t,s) = R_l(t) T_l(t,s) J R_l(s)^T.
```

For the two source vertices of column B, put Y_B = B_qp + B_pq^T and Y_B^c = R_q^T Y_B R_p. The bound drive is

```
Q_B(s) = −a(s)^4 f_B(s)
         [Σ_q(s) Y_B^c(s) J^T + J Y_B^c(s) Σ_p(s)].
```

The driven matrix equation

```
C_B′ = A_q C_B + C_B A_p^T + Q_B,    C_B(i) = 0
```

has the variation-of-constants representation

```
C_B(t) = ∫_i^t T_q(t,s) Q_B(s) T_p(t,s)^T ds.
```

Contracting R_q C_B R_p^T with the output vertex yields the source-time integral of the corresponding AQ retarded block before the one momentum integral. Both Wick orderings, the negative spectral relation and the once-counted source measure are included. This statement holds algebraically for all six output rows and six source columns with complete common inputs. [E03, E05]

The 060 review checked the matrix rearrangement and 288 exact rational comparisons on artificial matrices. These checks support the algebraic equality in that scope. They do not supply physical O049 mode histories or an independent numerical reference for the renormalized operator. [E03]

8.2 What the reformulation does not supply

The driven system can avoid the dense two-time storage table for the retarded action. It does not supply a complete uniform source basis, missing covariance evaluations, local terms, initial contacts, the N1 representation or regulator-limit error control. Nor does the one drive reconstruct all symmetric correlation fields returned separately by AQ. Those extra symmetric fields are not introduced here as additional obligations of the retarded gate. [E05]

The agreement of the renormalized limit requires the same common subtraction and adequate norm control; it is not a numerical consequence of a finite-regulator matrix identity alone. Parameters controlling momentum/time quadrature, source and output bases, repair prefixes, precision, regulator levels and reference work remain unbound. Thus SINGLE_TIME_ROUTE_READY = FALSE. The absence of a current cost bound is not a proof of an absolute cost lower bound or uncomputability. [E03-E06]

9. Remaining scientific gates and falsifiability

Three broad AP1 obligations remain: complete quantitative response acceptance over the required blocks and domains; stability beyond the local qualitative minimum; and the full own physical M1 early-to-present connection followed by quantitative prediction release. The last item includes two substantive tasks. Success on the θ subproblem alone would not complete this chain. [E01-E03]

The one immediate reopening condition is a complete executable O049 response package with the common state/history/transports, correct DC1/contact accounting, uniform source/N1 representation, prospective error and reference plan, and finite decision-capable cost bound. Until such a package is available, the single-time route remains frozen. Repeating only contracts, wrappers or bounds is not the missing material result. [E03, E05]

The accompanying predictions appendix preserves the earlier observational roadmap as conditional future work. Expansion, growth, lensing, filament residuals and gravitational-wave observables have no newly released numerical templates at this cutoff. They must be derived from a common defined model and frozen before their specified data comparison. Neither a null response field nor an unevaluated prediction may be used as an observational NONPASS. [E01-E03, B01]

The single-carrier interpretation remains a hypothesis. Genesis, dark-sector identifications, Higgs/QCD interpretations and black-hole reconversion are not results of the local O049 construction. Separate branch labels from the older publication corpus are not imported into the scientific endpoint of this release.

10. Reproducibility, provenance and historical boundary

The release supplies this manuscript, the current model contract, a claim-by-claim register, an explicit gap report, the predictions appendix, a feasibility statement, Priority Record v2, replacement website text and the audited evidence records. A source index records exactly which excerpts support current claims. Original evidence bytes and the two input archives are preserved. The file manifest and SHA-256 list support integrity checks; they do not constitute a physics reproduction.

The older v7.13 numerical classification remains in its frozen archive with its own independent-reproduction limitations. ORANGE workstream summaries, R195-specific calculations, the non-flat fixed-rho NONPASS and AP1_GO-078 declarations are historical/superseded for current-status reporting. Their old files are neither overwritten nor relabelled as if their original decisions had never occurred. In particular, superseding a status does not reverse the genuine historical fixed-rho NONPASS. The migration ledger locates those statements and their current replacements. [B01, B02, E01-E03]

The Priority Record dates this consolidation and cites inherited records. File hashes identify content, not the first public disclosure of an idea. This release makes no new novelty, legal-priority or third-party timestamp claim.

11. Conclusion

The supported result is a bounded Scientific Feasibility GO for the specified Variant-B/O049 realization under the declared local criteria. The common smooth construction, state/source binding, local dynamical admissibility and qualitative causal response are inherited positive findings. The compatible non-flat θ-source Ward test passes its quantitative budgets at $k = 1$.

The complete quantitative response remains RAW_RESPONSE_EVALUATOR_METHOD_LIMIT, and AP1_GO remains FALSE. The algebraic single-time route has not closed the missing executable-input, uniform-evaluation, reference or cost requirements. No stronger cosmological, stability or empirical conclusion is drawn. This is the scientific endpoint consolidated here.

Sources and declarations

Bracketed E-identifiers resolve through **SOURCES.md** in the release root to supplied unmodified technical records. B01 is the original document ZIP; B02 is the original homepage ZIP. The source index distinguishes current audit authority, inherited technical scope and superseded historical metadata. All main scientific findings above are attributed to those records; no external literature result or later branch is introduced as new evidence.

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