

A UMD Numerical Prediction Manifesto for Cosmological and Quantum Tests

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Abstract

We present an open register of numerical targets motivated by Universal Modular Dynamics (UMD) for use in cosmological, astroparticle, and open-quantum-system analyses. The purpose is not to claim experimental confirmation, but to publish explicit targets, search windows, null-model requirements, and falsification rules before future data are interpreted. The cosmological and astroparticle register contains a localized high-multipole CMB suppression target $\Delta C_\ell/C_\ell = -0.0914$ near $\ell = 2800$, the consistency targets $\Omega_{\text{DM}}/\Omega_b = 5.38$ and $\Omega_\Lambda = 0.683$, and a Galactic-centre gamma-ray spectral-break template with $E_b = 1.24 \pm 0.05$ TeV and $\Delta\gamma = 0.14 \pm 0.02$. The quantum register specifies a spectral-radius boundary $\rho_{\text{sp}}(J(H)) = 1$ and three residual-coherence targets, 0.914, 0.0581, and 0.0005, to be tested against continuous decoherence models by platform-neutral tomography. A numerical match is treated only as a candidate consistency observation: interpretation requires systematic controls, comparison with a preregistered null family, correction for multiple searches, and independent replication. The document therefore serves as a falsifiable experimental guide rather than as a derivation or a claim of established phenomenology.

Scientific-status statement. Every number in this document is a *preregistered numerical target* within the stated UMD-motivated phenomenological ansatz. None is represented as an experimentally established effect. Numerical proximity alone is not evidence for UMD unless the corresponding observable definition, null-model family, systematic controls, and decision rule are also satisfied.

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1 Introduction and Purpose of the Open Register

Universal Modular Dynamics is a proposed framework in which quantum states, modular structure, open-system evolution, and emergent geometric observables are treated within a common dynamical architecture [4, 5]. The present article isolates a small collection of numerical targets previously stated in three technical notes [1, 2, 3] and places them in one claim-calibrated, experimentally readable register.

The objective is practical: to help observational and experimental groups recognize what would count as agreement, disagreement, or an inconclusive test of these particular targets. Publishing the targets in advance reduces the freedom to move a search window, redefine an observable, or select a favourable subset after inspecting an outcome.

This article is not a derivation ledger for the listed numbers. It neither proves that the phenomenological map from UMD to cosmological or laboratory observables is unique nor asserts that a match would exclude conventional physics. Instead it freezes:

- (i) the target values and supplied uncertainties;
- (ii) the observable and baseline semantics;
- (iii) the intended search regions;
- (iv) the minimum null-model comparisons;
- (v) the interpretation and falsification policy.

Definition 1 (Preregistered numerical target). A preregistered numerical target is a value or interval fixed before the confirmatory dataset is analysed. It becomes an empirical prediction only through a frozen map from raw data to an estimator and a frozen decision rule.

The register has two parts. Part I concerns cosmological and astroparticle observations. Part II concerns open-quantum-system experiments. The two parts share a UMD-motivated transition language but remain empirically independent: success in one part cannot be used to repair a failed target in the other.

2 Common UMD Phenomenological Framework

2.1 Open-system dynamics

For a density operator ρ , the common open-system starting point is the Gorini–Kossakowski–Sudarshan–Lindblad equation [6, 7],

$$\frac{d\rho}{dt} = -i[H, \rho] + \sum_k \left(L_k \rho L_k^\dagger - \frac{1}{2} \{L_k^\dagger L_k, \rho\} \right). \quad (1)$$

Equation (1) is standard open-quantum-system structure. The additional claim that particular effective operators, thresholds, or macroscopic observables arise from UMD is model dependent and is not implied by the GKSL form alone.

2.2 Spectral boundary

Let $J(H; \lambda)$ be the frozen Jacobian associated with the selected UMD control map at parameter value λ . The transition boundary is written as

$$\rho_{\text{sp}}(J(H; \lambda_*)) := \max_{z \in \text{Spec}(J(H; \lambda_*))} |z| = 1. \quad (2)$$

This replaces the ambiguous expression $\text{Spec}(J(H)) = 1$. It also separates the spectrum from its characteristic equation,

$$\det(J(H; \lambda) - zI) = 0, \quad (3)$$

whose roots z determine the spectrum.

The terminology *Fast Mixing* and *Localized Propagation* denotes, respectively, the two sides of the proposed boundary. For any concrete test, the construction of J , the parameter λ , the estimator of $\rho_{\text{sp}}(J)$, and its uncertainty must be frozen before outcome inspection.

2.3 Claim hierarchy

The article distinguishes three levels:

- Level A: a numerical target is stated;
- Level B: a target is matched under its frozen protocol;
- Level C: UMD is preferred over the full alternative-model family. (4)

Level B does not imply Level C. Several targets, especially $\Omega_\Lambda = 0.683$, are naturally consistency targets rather than unique discriminators.

Part I

Cosmological and Astroparticle Numerical Targets

3 CMB High-Multipole Suppression

Let C_ℓ^{null} be the angular power spectrum of a frozen smooth reference cosmology after applying the same beam, transfer-function, foreground, mask, and calibration treatment used for the test model. Define

$$\delta_{\text{CMB}}(\ell) = \frac{C_\ell^{\text{test}} - C_\ell^{\text{null}}}{C_\ell^{\text{null}}}. \quad (5)$$

The UMD numerical target is

$$\boxed{\delta_{\text{CMB}}(\ell_*) = -0.0914, \quad \ell_* = 2800, \quad |\ell - \ell_*| \leq 50.} \quad (6)$$

Thus the predicted morphology is a localized 9.14% suppression centred on $\ell = 2800$, not an unrestricted amplitude fit over an arbitrarily selected multipole range.

A confirmatory analysis should freeze the spectrum estimator, frequency channels, sky masks,

foreground family, beam and transfer-function uncertainties, binning, covariance, templates, and look-elsewhere correction. Because the source note supplies no uncertainty for -0.0914 , it remains a point target. The acceptance tolerance must be fixed from instrumental and sampling uncertainty before unblinding.

4 Dark-Sector Consistency Targets

The previously ambiguous “mass ratio” is operationally defined as

$$R_{\text{DM/b}} := \frac{\Omega_{\text{DM}}}{\Omega_b}, \quad \boxed{R_{\text{DM/b}} = 5.38.} \quad (7)$$

If the originating UMD derivation intended a different ratio, the target must receive a new version identifier; it cannot be reinterpreted after comparison with data.

The second consistency target is

$$\boxed{\Omega_\Lambda = 0.683.} \quad (8)$$

The parameter convention, curvature assumption, neutrino sector, and dataset combination must accompany every comparison. Standard cosmological analyses already constrain closely related density parameters [8]; therefore agreement with (8) is not a unique UMD signature.

Equations (7) and (8) are consistency targets. A discriminating claim would require an additional UMD-specific correlation, scale dependence, or joint likelihood improvement not supplied by the source notes.

5 Galactic-Centre Gamma-Ray Spectral Break

Let E_b denote the break energy, F_b the flux at the break, γ_0 the lower-energy spectral index, and $\Delta\gamma$ the change in index. The continuous template is

$$\frac{d\Phi_{\text{br}}}{dE} = F_b \begin{cases} (E/E_b)^{-\gamma_0}, & E < E_b, \\ (E/E_b)^{-(\gamma_0+\Delta\gamma)}, & E \geq E_b. \end{cases} \quad (9)$$

The preregistered targets are

$$\boxed{E_b = 1.24 \pm 0.05 \text{ TeV}, \quad \Delta\gamma = 0.14 \pm 0.02,} \quad (10)$$

in the intended region

$$|l| < 1.5^\circ, \quad |b| < 1.5^\circ. \quad (11)$$

The source note also proposes

$$\boxed{\Delta\chi^2 > 12.5} \quad (12)$$

relative to a single-power-law fit. This is retained as a preregistered target, but it is not assigned a universal p -value: its significance depends on the number of added parameters, covariance, boundary conditions, and the energy and spatial search ranges.

The minimum alternative family should include a single power law, a smooth broken power law, exponential or sub-exponential cutoffs, diffuse-transport and foreground variants, unresolved-source populations, and allowed energy-response distortions. Galactic-centre observations already

exhibit nontrivial diffuse and source structure [9]. The target becomes discriminating only if it survives this family and independent replication.

For an idealized sharp break,

$$\gamma_{\text{local}}(E) = \gamma_0 + \Delta\gamma \Theta(E - E_b). \quad (13)$$

In a real instrument, energy dispersion and physical smoothing replace the distributional derivative by a finite-width transition. The width must therefore be fitted rather than assumed to vanish.

Part II

Quantum Open-System Numerical Targets

6 Operational Definition of the Quantum Boundary

The quantum test is platform neutral. It applies only after specifying the state space and Hamiltonian family $H(\lambda)$, effective dissipators, control map and Jacobian, spectral-radius estimator, initial-state ensemble, readout map, and pre/post-boundary control regions.

The target transition point is

$$\boxed{\rho_{\text{sp}}(J(H; \lambda_*)) = 1.} \quad (14)$$

The estimate of λ_* must be obtained without using the later coherence-plateau outcome. Otherwise boundary selection and plateau testing would not be statistically independent.

7 Predicted Coherence Plateaus

For a selected logical two-level subsystem, define normalized residual coherence by

$$\gamma(t; \lambda) = \frac{|\rho_{01}(t; \lambda)|}{|\rho_{01}(0; \lambda)|}, \quad 0 \leq \gamma \leq 1. \quad (15)$$

For larger systems, a different witness may be used only if its semantics are frozen before acquisition. State fidelity is recorded separately and cannot be substituted for γ after inspection.

The three preregistered levels are

$$\boxed{\gamma_1 = 0.914, \quad \gamma_2 = 0.0581, \quad \gamma_3 = 0.0005.} \quad (16)$$

The predicted content is a discrete ordered plateau structure rather than a generic monotone loss of coherence.

The source protocol supplies no plateau durations, transition times, or uncertainties. A confirmatory test must therefore freeze the control path, observation times, minimum plateau duration, level uncertainty, readout-error correction, and allowed number and ordering of plateaus.

At minimum, the plateau model must be compared with

$$\gamma_{\text{exp}}(t) = Ae^{-t/T_2} + c, \quad (17)$$

$$\gamma_{\text{G}}(t) = Ae^{-(t/T_{\text{G}})^2} + c, \quad (18)$$

$$\gamma_{\text{str}}(t) = Ae^{-(t/T)^\alpha} + c, \quad \alpha > 0. \quad (19)$$

A device-specific non-Markovian model must be included when calibration data require one.

8 Platform-Neutral Tomographic Protocol

Protocol 1 (Outcome-blind coherence-step test). Step 1. **Device calibration.** Estimate preparation, readout, crosstalk, drift, and decoherence baselines without fitting UMD levels.

Step 2. **State preparation.** Prepare the frozen initial-state ensemble with randomly interleaved calibration shots.

Step 3. **Boundary sweep.** Sweep λ through a frozen interval surrounding the independently estimated spectral-radius boundary defined by $\rho_{\text{sp}}(J(H; \lambda)) = 1$.

Step 4. **Tomographic acquisition.** Reconstruct the frozen coherence witness at preregistered times. Randomized measurements may be used when full tomography is impractical [10].

Step 5. **Blind model fitting.** Fit the plateau model and complete null family without changing target levels or search windows.

Step 6. **Adjudication.** Apply the frozen rule and report failed, excluded, and missing shots.

Step 7. **Replication.** Repeat on independent subarrays, days, control sequences, and, where possible, a second architecture.

Programmable neutral-atom arrays are one possible implementation context, but this document does not claim an official collaboration with any hardware provider. No company-specific backend name is part of the prediction.

9 Unified Numerical-Target Registry

Table 1: Frozen numerical-target registry.

Sector	Observable	Target	Search region	Minimum comparison
CMB	δ_{CMB}	-0.0914	$\ell = 2800 \pm 50$	Smooth reference plus nuisance/foreground family
Dark sector	$\Omega_{\text{DM}}/\Omega_b$	5.38	Frozen cosmological parameterization	Joint posterior under identical data and priors

Sector	Observable	Target	Search region	Minimum comparison
Dark energy	Ω_Λ	0.683	Frozen curvature, neutrino, and data assumptions	Standard fit; consistency target only
Gamma ray	E_b	1.24 ± 0.05 TeV	$ l , b < 1.5^\circ$	Smooth breaks, cutoffs, foregrounds, sources, response shifts
Gamma ray	$\Delta\gamma$	0.14 ± 0.02	Same as above	Same as above
Gamma ray	$\Delta\chi^2$	> 12.5	Frozen energy and spatial domain	Calibrated full alternative family
Quantum	$\rho_{\text{sp}}(J)$	1	Frozen control sweep	Independent boundary estimate
Quantum	$\gamma_1, \gamma_2, \gamma_3$	0.914, 0.0581, 0.0005	Frozen times and durations	Continuous and device-specific nulls

10 Interpretation, Falsification, and Reporting Rules

Each target receives one of three outcomes:

Matched

The frozen estimator and its uncertainty satisfy the target rule, the preferred template survives all mandatory controls, and the result is not created by post-outcome retuning.

Not Matched

The target is excluded at the frozen confidence or evidence threshold, or the predicted morphology is absent despite adequate sensitivity.

Inconclusive

Sensitivity is insufficient, required controls fail, the result depends on an unresolved nuisance model, or no target tolerance was frozen.

A MATCHED result means only that data are consistent with the frozen UMD numerical target. It does not uniquely establish UMD. Promotion requires a broad alternative-model comparison, a derivation of target specificity, and independent replication.

Targets may not be treated as statistically independent without a covariance model. Any combined statistic must account for shared calibration, datasets, systematics, and assumptions. Selective publication invalidates a combined claim.

Every later change to a value, observable, uncertainty, window, null family, or threshold creates a new version. The original target remains in the public ledger with its outcome.

11 Limitations and Domain of Validity

Limitation 1 (No derivation claim). This document consolidates targets from supplied UMD technical notes. It does not independently certify the complete derivation of each number.

Limitation 2 (No common-scale theorem). The cosmological, gamma-ray, and quantum targets share a proposed UMD language, but this article does not prove that they descend from one uniquely normalized parameter or one established universality class.

Limitation 3 (No confirmation by coincidence). Agreement with one point target, especially a standard cosmological parameter, cannot identify UMD.

Limitation 4 (Target-relative falsification). A well-powered NOT MATCHED result falsifies the corresponding frozen target contract. It does not automatically falsify every mathematical formulation of UMD unless that formulation proves the target necessary.

Limitation 5 (Unspecified uncertainties). Targets without uncertainties cannot receive a confirmatory MATCHED verdict until an outcome-blind tolerance and coverage rule have been frozen.

12 Conclusion

This manifesto converts three separate UMD technical notes into one open, versioned, and falsifiable numerical-target register. Its cosmological and astroparticle component freezes a localized CMB suppression, two dark-sector consistency values, and a Galactic-centre gamma-ray break. Its quantum component freezes a spectral-radius boundary and three residual-coherence levels to be tested against continuous-decoherence alternatives.

Experimental groups are invited to report positive, negative, and inconclusive outcomes under transparent null models and controls. The central rule is

publish the target before the outcome, and publish the outcome whether or not it matches.

A Exact Numerical Target Registry

CMB amplitude:	$\delta_{\text{CMB}} = -0.0914,$
CMB centre:	$\ell_* = 2800,$
CMB half-window:	$\Delta\ell = 50,$
dark-to-baryonic ratio:	$R_{\text{DM/b}} = 5.38,$
dark-energy parameter:	$\Omega_\Lambda = 0.683,$
gamma-ray break:	$E_b = 1.24 \pm 0.05 \text{ TeV},$
spectral-index change:	$\Delta\gamma = 0.14 \pm 0.02,$
fit-improvement target:	$\Delta\chi^2 > 12.5,$
gamma-ray region:	$ l , b < 1.5^\circ,$
quantum boundary:	$\rho_{\text{sp}}(J(H; \lambda_*)) = 1,$
coherence levels:	$(\gamma_1, \gamma_2, \gamma_3) = (0.914, 0.0581, 0.0005).$

Only the gamma-ray break energy and index change carry source-supplied uncertainties. No uncertainty is silently inferred for the remaining targets.

B Recommended Fit and Tomography Templates

For a frozen localized CMB shape W_ℓ , normalized by $W_{\ell_*} = 1$, a minimal template is

$$C_\ell^{\text{test}} = C_\ell^{\text{null}}(1 + A_{\text{CMB}}W_\ell), \quad A_{\text{CMB}}^{\text{TARGET}} = -0.0914. \quad (20)$$

The width and shape of W_ℓ must be frozen or treated as fitted parameters with a look-elsewhere correction.

The gamma-ray template (9) must be convolved with the instrument response:

$$\mu_i(\boldsymbol{\theta}) = \int R_i(E_{\text{rec}}, E) \frac{d\Phi_{\text{br}}}{dE} dE + b_i(\boldsymbol{\eta}), \quad (21)$$

where R_i is the frozen response operator and b_i the background/foreground model.

A generic ordered three-plateau model is

$$\gamma_{\text{pl}}(t) = \sum_{j=1}^3 \gamma_j \mathbf{1}_{[\tau_{j-1}, \tau_j)}(t) + \gamma_{\text{tail}} \mathbf{1}_{[\tau_3, \infty)}(t), \quad 0 = \tau_0 < \tau_1 < \tau_2 < \tau_3. \quad (22)$$

Sharp indicators may be convolved with the timing response or replaced by a frozen smooth kernel. Transition times and durations are nuisance parameters only under a preregistered rule.

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