**Absolute Relativity / Overall V2 Theory – v0.9**  
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**Simulation Attachment – Part II (V2 Simulations)**

**1. Orientation & Scope**

**1.1 Role of Part II relative to Part I (V1 sims)**

Part I of the Simulation Attachment documented the **V1-era simulation suite**. Those simulations operated directly on the original, more abstract V1 structures:

* Operator algebra (flip operators, commutators, Casimir, etc.).
* Ladder and kernel constructions (tick chains, Vol.3 kernels).
* Gauge-sector simulations (Vol.4 lattice modules, FPHS pipeline).
* Early gravity and measurement tests (MICC, kernel→metric, compact curvature, pointer designs).

The emphasis in Part I was on **internal consistency of the formal framework**:

* Showing that the operator algebra behaves as intended.
* Demonstrating that the ladder and kernel structures reproduce the expected geometric and gauge-theoretic behaviour.
* Establishing compact-curvature kernel→metric translations and identifying one deliberate obstruction (the naive Sim 2 kernel→metric failure).
* Designing (but not fully completing) the pointer classicalization/measurement story at the V1 level.

By contrast, **Part II** records the **V2/V2.1 simulation era**, where the same underlying theory is realised in the **present-act engine** and then connected to real astrophysical data:

* At the engine level, simulations work directly with:
  + Sites (k) and world/qualia records (W\_k, Q\_k).
  + Finite feature alphabets and exact hinge equality.
  + Boolean/ordinal gates (Θ, κ, structural gates, MICC, ParentGate).
  + Ratio-lex acceptance with PF/Born applied only to true ties.
  + Typed budgets and the SR identity as hard constraints.
* At the data level, simulations include:
  + Matter-Addition and UGM-to-gravity runs that push the engine into realistic “gravity-like” regimes.
  + External-catalogue tests (rotation curves, RAR, lensing plateaus) that compare engine- and theory-level expectations with galaxy data.

In other words:

* **Part I** answers:  
  *“Does the abstract V1 framework behave coherently when we simulate its own internal objects (operators, kernels, lattices)?”*
* **Part II** answers:  
  *“Does the V2/V2.1 present-act engine correctly implement that same structure, and what happens when we carry it all the way out to real astronomical data?”*

Both parts are meant to be read together:

* The **Bridge document** shows how V1 objects map into the engine language.
* **Part I** verifies the V1 objects in their own native setting.
* **Part II** shows the mapped objects **actually running** inside the engine and then being tested against real-world datasets.

This attachment (Part II) is therefore the **engine-and-data companion** to Part I: it completes the story from **formal framework → engine implementation → simulations → observational contact**, and serves as the archival record of everything that has been done at the V2/V2.1 level.

**1.2 V2/V2.1 engine basics**

The V2/V2.1 present-act engine is the **operational realization** of the V1 framework. Instead of working directly with abstract operators and lattices, it works with a discrete, step-by-step process in which “what actually happens next” is selected under strict rules.

At its core, the engine is built from the following pieces.

**1.2.1 Sites, records, and feature alphabet**

* The engine evolves over **sites** (k), which you can think of as addresses or locations in a discrete configuration graph.
* At each site (k), the engine maintains:
  + A **world record** (W\_k), containing the external/physical features at that site.
  + A **qualia record** (Q\_k), containing the internal/experiential or observer-facing features.
* All records are drawn from a **finite feature alphabet**:
  + Features are discrete symbols or small integers.
  + Comparisons are done via **exact equality** in feature space (no floating-point closeness).
  + This is where the **hinge equality** from V1 is implemented concretely.

This setup ensures that every engine act operates on a finite, combinatorial state, with no hidden continuous parameters in the control logic.

**1.2.2 Gates and ratio-lex acceptance**

Changes to the records are governed by **gates** and a strict selection rule:

* Gates are **boolean/ordinal** objects. The main families are:
  + Θ-gates and κ-gates that enforce structural and feasibility conditions.
  + Measurement gates (MICC-style) that control branching and decoherence.
  + The **ParentGate**, which implements gravitational feasibility.
* For each act, the engine considers a finite set of **candidate transitions** and evaluates them under all relevant gates:
  + Candidates that fail any hard gate are discarded.
  + Surviving candidates are ranked using **ratio-lex acceptance**:
    - First by ratios (e.g., feasibility scores or counts).
    - Then by lexicographic order over a finite priority list.
* There is **no curve-fitting or continuous weighting** inside this selection:
  + All continuous-looking curves (e.g. deflection vs impact parameter) appear only in diagnostics, as summaries of many discrete acts.
  + Control itself is entirely discrete and ordinal.

Only when ratio-lex ends in a **true tie** (two or more candidates exactly equal at all levels) does the engine invoke probabilistic selection.

**1.2.3 PF/Born ties-only rule**

Randomness is confined to a very specific role:

* If there is a **unique best** candidate after all gates and the ratio-lex ordering, the engine chooses that candidate **deterministically**.
* If there is a **tie** among multiple best candidates:
  + The engine applies a **PF/Born rule** on that tie set.
  + Weights are determined by a primitive, pre-specified kernel (not fitted to data).
  + A pseudo-random generator, with controlled seeding, selects the actual outcome among tied candidates.

This “PF/Born ties-only” discipline is enforced everywhere:

* There is no ad hoc randomness to smooth curves or fix anomalies.
* No-signalling tests and replay tests check that:
  + Tie handling is deterministic up to the RNG seed.
  + Diagnostics do not leak into control.
  + Outcomes respect the expected Born-like frequencies when ties are present.

**1.2.4 Typed budgets and SR identity**

Each act in the engine carries **typed budgets**:

* Proper-time budget (\Delta \tau).
* Coordinate-time budget (\Delta t).
* Spatial budget (\Delta x) (or its discrete analogue).

These are constrained by a special-relativistic identity:

[  
\Delta t^2 = \Delta \tau^2 + \frac{\Delta x^2}{c^2},  
]

with a fixed (c) that plays the role of the maximum signal speed in the engine:

* **Speed bound:** reachable displacements per tick are limited so that effective velocities satisfy (v \le c).
* **Light-cone structure:** reachability regions over many steps reproduce discrete light-cones.
* **Dilation:** different drift rates through configuration space give rise to SR-like dilation curves when read out over longer runs.

These budgets are part of the **engine contract** and are tested directly by the V2 simulations (Section 2 and Section 3).

**1.2.5 ParentGate and MICC as special gate roles**

Two gate families play central roles in the simulations:

* **ParentGate (gravity):**
  + Encodes **gravitational feasibility** by making some moves more or less allowed, depending on position, band, and hinge scale.
  + Implements strictness schedules (e.g. radial profiles) that can generate:
    - Feasibility gradients (“downhill” directions).
    - Horizons (regions where outward moves become NoCommit).
  + Is the **only** gate allowed to play the role of “gravity” in V2/V2.1 simulations.
* **MICC-style measurement gates:**
  + Model measurement and decoherence by controlling when and how branches are distinguished and stabilized.
  + Parameterised by a measurement fraction (f) in some scenarios.
  + Used both in simple interference/decoherence tests and in more complex pointer and lensing setups.

Together, these components—sites and records, finite feature alphabet, gate families, ratio-lex with PF/Born ties-only, typed budgets, and the special roles of ParentGate and MICC—define the **operational platform** on which all V2/V2.1 simulations in this attachment are run.

**1.4 Code availability & reproducibility policy**

All of the V2 and V2.1 simulations described in this attachment were implemented in **private repositories**. The purpose of this section is to make clear what exists, how it is organised, and what would be required to reproduce any given result.

**1.4.1 Private repositories and access**

* The engine core, matter-addition suite, and T-series analysis scripts live in a set of internal repos under your control.
* For the purposes of this document:
  + We treat those repos as the **canonical implementations** of the simulations.
  + They are **not public**, but:
    - Code, manifests, and configuration files can be shared with collaborators **on request**.
* This attachment does not attempt to mirror the full file structures; instead it:
  + Names the simulation families (A1–J28, UGM triad, T1–T3-B, etc.).
  + Describes the logic, setup, and results in enough detail to know what each repo/run is doing.

**1.4.2 What is recorded in this attachment**

For each simulation family, this attachment records:

* **Conceptual setup**
  + What the simulation is testing (e.g. SR identity, Gauss-like plateaus, MW-size activation).
  + Which engine components are active (ParentGate, MICC, band choice, schedule type).
* **Run structure**
  + How initial conditions and parameter sweeps are organized (e.g. meshes, impact-parameter grids, mass/size bins).
  + The key diagnostics and audit checks (mesh pairs, flatness gates, no-signalling, etc.).
* **Key results**
  + Main fit parameters (slopes, amplitudes, thresholds).
  + Qualitative patterns (e.g. positive size trends, MW-scale cutoff, presence/absence of activation).
  + Pass/Pending/Neutral status for each family.

The goal is to have a **self-contained narrative** of what was done and what was found, without relying on external documentation.

**1.4.3 What would be needed to reproduce the simulations**

Although the repos themselves are private, the simulations are intended to be reproducible in principle. A technically competent reader would need:

* For **engine-level simulations** (Sections 2–4):
  + A description of the present-act engine:
    - Site structure and feature alphabets.
    - Gate semantics (Θ, κ, MICC, ParentGate).
    - Ratio-lex acceptance and PF/Born ties-only rule.
    - Budget handling and SR identity enforcement.
  + The relevant **manifest format**:
    - How to encode band choice, schedules, strictness profiles, and audit options.
  + The parameter values and schedules described in each subsection of this attachment.
* For **external-data simulations** (Sections 5–6):
  + Access to the same catalogues (SPARC, KiDS, DR5, etc.).
  + The selection cuts, binning schemes, and flat-window/plateau definitions given later in the text.
  + The fitting and comparison procedures (e.g. how slopes, amplitudes, AIC differences are computed).

With those ingredients plus the code (on request), the simulations could be rerun and the outputs checked against the patterns listed here.

**1.4.4 Role of this document in your workflow**

This attachment is intended to be:

* The **archival record** of the V2/V2.1 simulation programme:
  + A place where the logic, setups, and results are all written down in one coherent structure.
  + Suitable for timestamping on the blockchain as a stable reference.
* The source from which:
  + Future summaries, papers, and more condensed technical documents can be derived.
  + Additional, more focused write-ups (e.g. on specific T-series results) can be built without losing the original context.

All later work that cites these simulations can refer back to this attachment as the authoritative description of what was actually run at the V2/V2.1 level.

**1.5 Purpose and structure of this attachment**

The purpose of this document is to create a **complete, coherent record** of the V2/V2.1 simulation programme as it currently stands:

* It collects all the major V2 simulation families in one place.
* It explains **why** each simulation was run, **how** it was set up, and **what** it showed.
* It is written for **your own long-term use**: as something you can timestamp on the blockchain and later mine for more compact technical write-ups.

This attachment is not trying to be the most compressed or “paper-ready” version. Instead, it is intended to:

* Preserve **context and reasoning**, not just final numbers.
* Make it clear how the pieces (engine, matter-addition, UGM, T-series) fit together.
* Provide a stable reference point so that future summaries and publications can be traced back to a clear origin.

**1.5.1 What this document does**

This attachment:

* **Follows the same general style as Part I**, but in engine language:
  + Each simulation family has a clear purpose, setup, method, results, and status.
  + Where relevant, the connection to V1 simulations or volumes is made explicit.
* **Separates different levels of testing**:
  + Engine sanity and structure (locality, SR budgets, PF/Born discipline, decoherence).
  + Matter-addition behaviour and hinge-scale gravity geometry (A1–J28, UGM triad).
  + External-data contact with galaxy catalogues (T1–T3-B).
* **Records interpretation choices**:
  + How you understood the outcomes (e.g. why a pattern is considered a pass, neutral, or pending).
  + How later work (like T3-B) changed the interpretation of earlier results (e.g. low-mass T3 bins now seen as predicted non-activation).

In short, it’s a **narrative plus technical log** of what you’ve actually done with V2/V2.1 so far.

**1.5.2 How the later sections are organised**

The later sections are structured to mirror the logical flow of your work:

* **Section 2 – Core engine simulations**  
  Establishes that the present-act engine behaves as intended:
  + Locality, SR budgets, PF/Born ties-only.
  + Basic gravity-analogue and information-geometry scenes.
  + Decoherence and hygiene baselines.
* **Section 3 – Matter-Addition suite (A1–J28)**  
  Explores what happens when a matter schedule is added:
  + Counts-only EM analogues (Gauss-like plateaus, E/B oscillations).
  + Geometry under gravity (redshift, delay, deflection, horizons).
  + Mesh/re-centring integrity and spectroscopy-like structures.
* **Section 4 – UGM → gravity triad (V2.1)**  
  Shows that a single hinge-scale amplitude chain can fit:
  + Deflection.
  + Shapiro-like delay.
  + Gravitational redshift.
* **Section 5 – External rotation & RAR (T1–T2)**  
  Connects the theory and engine to rotation-curve and RAR behaviour:
  + T1: rotation-plateau machinery.
  + T2: RAR scaling with low-g slope ~1/2 and single g\* scale.
* **Section 6 – Galaxy–galaxy lensing plateaus (T3 & T3-B)**  
  Gives extra detail for the most significant and subtle results:
  + Size–plateau trends at fixed stellar mass.
  + Milky-Way–anchored activation model.
  + The shared cutoff pattern in KiDS and DR5 and its tension with basic GR expectations.
* **Section 7 – Global status & relation to V1**  
  Summarises which families have passed, which are pending, and how V2 completes the V1 story.
* **Section 8 – Code & reproducibility notes**  
  Clarifies that the implementations are private but reproducible in principle, and notes what a future re-run would require.

This structure is meant to make it easy, later on, to:

* Pull out specific blocks (e.g. “UGM triad”, “T3-B lensing”) for a more compact technical document.
* See at a glance how each block hangs together in the larger picture of the theory, the engine, and the data.

**2. Core Engine Simulations (Group-1 / SR / Info-Geometry)**

This section records the **core V2 engine tests** that do not yet involve the full matter-addition schedule or external datasets. Their job is to show that:

* The present-act engine respects its own contract (locality, SR budgets, PF/Born ties-only).
* The same combinatorial rules can produce interference, decoherence, complementarity, and gravity-style behaviour **without** curve weights or metric fields.
* Hygiene conditions (no diagnostics leak, no hidden signalling) are actually enforced in practice.

These simulations form the foundation on which the later Matter-Addition, UGM, and T-series runs are built.

**2.1 Locality, budgets & PF/Born discipline**

This group of tests checks the **bare engine mechanics** before adding gravity schedules or external data.

**2.1.1 Locality and no-skip**

Setups:

* Simple travel scenes on lattices or graphs, where each node has a small, fixed neighbour set (e.g. forward + sideways moves).
* Control files restrict candidate transitions to this neighbour set only.

Checks:

* In all runs, committed acts only ever move to allowed neighbours; no “teleportation” or long hops occur.
* Commuting “squares” in the reachable graph (e.g. up-then-right vs right-then-up) yield the same final state when both paths are feasible.

Outcome:

* Locality and no-skip are enforced at the level of the engine loop itself, not just assumed by the theory.

**2.1.2 Typed budgets and SR identity**

Setups:

* Drift scenes where a subsystem moves with a controlled drift parameter through the configuration graph.
* For each committed act, the engine logs ((\Delta \tau, \Delta t, \Delta x)).

Checks:

* The SR identity  
  [  
  \Delta t^2 = \Delta \tau^2 + \frac{\Delta x^2}{c^2}  
  ]  
  holds for each step within integer/finite precision.
* Over many steps, effective velocities satisfy (v \le c), and discrete light-cones appear as reachability regions.
* Aggregated runs show the expected dilation curves when plotted vs drift parameter.

Outcome:

* The SR structure is realised as a **hard constraint** on budgets in actual runs, and not violated by any of the later gravity-style or information-theoretic scenes.

**2.1.3 PF/Born ties-only and no-signalling**

Setups:

* Tiny scenes explicitly engineered to produce:
  + Cases with a **unique** best candidate after ratio-lex.
  + Cases with genuine **ties** between top candidates.

Checks:

* In unique-best cases, the chosen outcome is always deterministic and independent of the RNG seed.
* In tie cases:
  + The PF/Born selector is invoked only on the tie set.
  + Tie outcome frequencies over many runs match the primitive kernel weights.
* In two-wing configurations:
  + Wing marginals are independent of local settings on the distant wing.
  + No-signalling holds at block level and globally, even when tie rates are non-zero.

Outcome:

* Randomness is strictly confined to tie resolution.
* There is no evidence of hidden stochasticity elsewhere in control, and no signalling appears from tie handling.

**2.2 Q-series: gravity-analogue & information-geometry scenes**

Here the engine is used to explore **gravity-style and optical behaviour** using only feasibility gradients and gate structure. These sims still use minimal worlds, not full matter-addition.

**2.2.1 Q1 – Gravitational interferometer (structural phase)**

Setup:

* A two-arm interferometer with equal path length in step counts.
* One arm lies deeper in a ParentGate strictness profile than the other (more “costly” in feasibility terms).

Diagnostics:

* Output port frequencies over many runs.
* Tie-rates and neutrality of intermediate regions.

Result:

* A stable port bias appears that depends on relative depth in the ParentGate profile, even though path lengths are equal.
* This bias behaves like a **redshift-style structural phase**: it is generated purely by feasibility, without metric fields, potentials, or curve weights.

**2.2.2 Q2 – JFM focusing funnel**

Setup:

* A funnel-shaped region where feasibility is higher along a central corridor and lower towards the sides.
* Candidates represent possible “rays” or paths through this corridor.

Diagnostics:

* Joint focus measures (e.g. JFM) and CRA/TCG statistics over histories.
* Counts of hits in a “focus region” vs the surrounding area.

Result:

* Paths concentrate into the high-feasibility corridor.
* Focus quality (JFM, CRA/TCG) improves as the funnel is made sharper.
* Behaviour is lens-like and consistent with the idea that, in a continuum limit, these discrete feasibility rules would approximate Fermat-type geodesics.

**2.2.3 Q3 – Horizon proximity scene**

Setup:

* A radial strictness schedule with strictness increasing sharply inward.
* Outward moves beyond a certain radius (r\_h) are heavily suppressed or marked NoCommit.

Diagnostics:

* Reachability sets over many steps from interior and exterior starting points.
* Neutrality and tie-rates inside and outside the putative horizon.

Result:

* A clear **horizon radius** appears:
  + Inside: some outward moves are still feasible, but they cannot escape beyond (r\_h) over the run length.
  + Outside: inward access is possible; outlook from inside is effectively “sealed”.
* The interior region becomes neutral with respect to further outward escape.

**2.2.4 Q4 – CHSH under a local feasibility gradient**

Setup:

* A standard CHSH ±1 configuration with two wings and setting choices.
* A local gravity-style gate (feasibility gradient) applied on one wing only.

Diagnostics:

* CHSH S value as a function of gradient strength.
* Local marginals on each wing and block-by-block balance.

Result:

* S decreases smoothly as gradient strength increases, as expected when one wing’s feasible alternatives are restricted.
* Local marginals remain at 0.5 within numerical tolerance.
* Block counts remain balanced; no signalling appears, despite the local gradient.

**2.2.5 Q5 – Complementarity in a spatial gradient**

Setup:

* A two-path interference scene with a which-way meter whose effective reliability depends on position in a gradient.
* Feasibility of which-way marks vs unmarked paths is modulated spatially.

Diagnostics:

* Visibility V of interference fringes.
* Distinguishability D of which-way information.
* Combined quantity (V^2 + D^2).

Result:

* As the meter is made more reliable (in feasibility terms), V decreases and D increases.
* Across the sweep, (V^2 + D^2 \le 1) holds within numerical tolerance.
* Complementarity appears as a statement about **feasible alternatives in the engine**, rather than requiring explicit wave amplitudes.

**2.3 Decoherence, interference & hygiene baselines**

This group provides the **baseline interference and decoherence scenes** that support both the Q-series and later matter-addition and lensing simulations.

**2.3.1 Two-slit and decoherence sweeps**

Setups:

* Two-slit-style scenes where:
  + A “pure” interference case is run first.
  + Then phase noise, which-path marks, and measurement fraction (f) are introduced in controlled ways.

Diagnostics:

* Interference visibility V vs:
  + Phase noise at readout (pure dephasing).
  + Boolean which-path marks in a tie zone (collisional decoherence).
  + Effective reliability of a binary which-way meter.
* Branch structure and tie-rates as functions of (f).

Results:

* Pure dephasing at readout reduces visibility as expected without changing acceptance.
* Boolean which-path marks alone reproduce textbook-like visibility decay.
* Complementarity trade-offs (V vs which-path reliability) match the expectations encoded in the Q-series.

**2.3.2 Hygiene and integrity checks**

Setups:

* Pairs of runs with:
  + Identical control but different levels of diagnostics (extra logging, more CRA/TCG, etc.).
  + Replay runs seeded from previously recorded tie decisions.

Diagnostics:

* Control-path hashes (sequence of committed acts).
* Counts of ties, NoCommit events, and accepted candidates.
* Equality tests between baseline and replay/hygiene runs.

Results:

* Control paths are identical between baseline and diagnostics-heavy runs; diagnostics never feed back into control.
* Replay runs reproduce exactly the same sequence of tie outcomes when seeded with the original RNG state.
* These checks support later claims that more complex behaviours (e.g. in T-series sims) arise from the intended feasibility structure, not from accidental diagnostics or uncontrolled randomness.

Together, Sections 2.1–2.3 establish that the **engine itself** behaves correctly and that basic interference, decoherence, complementarity, and gravity-analogue behaviour can be obtained from its rules before any additional matter-addition or astrophysical data are brought in.

**3. Matter-Addition Suite (A1–J28)**

The Matter-Addition suite is the main block of V2 simulations where the present-act engine is run with a **single “matter schedule”** layered on top of the core mechanics. The idea is to see how far you can get, in practice, by:

* Leaving the engine contract (sites, gates, budgets, PF/Born ties-only) untouched.
* Modulating only **feasibility** via a ParentGate-style schedule.
* Reading out what happens to effective “fields”, geometry, and structure using **counts-only diagnostics**.

The A1–J28 runs establish that this approach is coherent and robust: they reproduce SR behaviour, EM-like plateaus and oscillations, gravity-like deflection/delay/redshift, horizon behaviour, and spectroscopy-style structure, all with strong mesh and hygiene checks.

**3.1 Design goals & shared audit conditions**

The Matter-Addition suite was designed around three core goals:

1. **Minimal intervention:**
   * Keep the V2 engine contract fixed.
   * Introduce “matter” only as a **schedule** that modulates the ParentGate’s strictness in space and/or band.
   * No extra forces, no explicit potentials, no continuous weight functions in control.
2. **Counts-only geometry and EM analogues:**
   * Show that familiar field-like behaviours (Gauss plateaus, 1/r laws, E/B oscillations, horizons) can be recovered from:
     + Discrete counts of events in shells, loops, and sectors.
     + Strictness/feasibility patterns encoded in the schedule.
   * No field variables or differential equations are ever part of engine control.
3. **Robustness and auditability:**
   * Every “interesting curve” must pass:
     + **Mesh certification**: coarse vs fine grids give the same slopes/amps within tight tolerances.
     + **Re-centring** tests where applicable.
     + **Boundary-mask** tests where applicable.
   * Where amplitudes matter, they must be compatible with a shared amplitude family (e.g. via the Earth-ring).

Across all A1–J28 runs, the following **shared audit conditions** are used:

* **Mesh pairs:**  
  For key panels, the same scenario is run on at least two different meshes; slopes and amplitudes must agree (within a set tolerance) and the curves correlate ~1.
* **Re-centring:**  
  Where geometry is radial or central, panels are re-run with shifted centres; the resulting curves must overlay within tolerances.
* **Boundary masks:**  
  For extended domains, outer masks may be applied to damp activity. The form (shape) of curves must stay the same; only amplitude is allowed to change.
* **Neutrality checks:**  
  In panels designed to be “neutral” (e.g. amplitude unaffected by switching ON/OFF matter), any measured difference must be at or below noise level.
* **No hidden tuning:**  
  Schedules, thresholds, and binning choices are fixed by simple design rules and reused; there is no per-panel curve-fitting inside control logic.

These audits make A1–J28 the main **stress test** that the matter schedule behaves like a coherent, reusable object rather than a one-off tuning gadget.

**3.2 Baseline SR & isotropy (A1–A3)**

The A-block confirms that turning the matter schedule ON does **not** break the basic SR or symmetry structure of the engine.

**A1 – SR baseline (schedule OFF)**

* **Purpose:**  
  Establish a clean SR baseline with no matter schedule at all.
* **Setup:**
  + Engine run with ParentGate and matter schedule disabled (OFF).
  + Drift scenes and light-cone style reachability, as in the core SR tests.
* **Result:**
  + Light-cones and effective velocities match the SR expectations.
  + γ(α) curves and budget identity hold across the run.
* **Status:** PASS — SR is intact in the matter-free baseline.

**A2 – Isotropy audit (schedule ON)**

* **Purpose:**  
  Check that turning the schedule ON does not introduce spurious anisotropy.
* **Setup:**
  + Same basic geometry as A1, but with the matter schedule active.
  + Parity sectors and angular bins defined on shells.
* **Result:**
  + Sector counts stay uniform within small deviations set by finite sampling.
  + No preferred directions are introduced by the schedule.
* **Status:** PASS — schedule respects isotropy at the tested level.

**A3 – Monotone strictness ladders**

* **Purpose:**  
  Verify that strictness only increases inward (never relaxes in the “wrong” direction).
* **Setup:**
  + Ladder strictness values are recorded for each band/shell.
  + Code checks for any violations of the intended inward-nondecreasing pattern.
* **Result:**
  + Zero monotonicity violations.
* **Status:** PASS — schedule meets its designed monotone behaviour.

**3.3 Measure invariance & amplitude anchors (A4–B6)**

This block checks that basic measurement objects are stable and that amplitude calibration is well-defined.

**A4 – Single-read measure discipline**

* **Purpose:**  
  Ensure that hinge and measure files are read once and not reinterpreted mid-run.
* **Setup:**
  + Run with logging of all file opens and reads.
  + Hashes of measurement files checked before and after.
* **Result:**
  + Single-read discipline is obeyed; hashes are stable.
* **Status:** PASS — measurement definitions are operationally invariant.

**B5 – Surface amplitude neutrality (OFF vs ON)**

* **Purpose:**  
  Confirm that adding matter does *not* change a designed neutral surface amplitude.
* **Setup:**
  + Two-anchor configuration with a panel designed to have a neutral far-field amplitude.
  + Runs with matter schedule OFF and ON.
* **Result:**
  + Difference in far-field amplitude is at noise level (∼10⁻⁸ type).
* **Status:** PASS — schedule does not covertly “cheat” amplitude where neutrality is required.

**B6 – Earth-ring amplitude calibration**

* **Purpose:**  
  Install a reproducible amplitude anchor for later gravity-style simulations.
* **Setup:**
  + Thin “Earth-ring” geometry used as a calibrator.
  + Amplitude measured under the matter schedule.
* **Result:**
  + Measured amplitude aligned with the intended normalization (≈1 in the chosen rescaled units).
* **Status:** PASS — Earth-ring provides a stable amplitude anchor.

**3.4 Counts-only EM analogue (D9–D12)**

These D-block panels show that EM-like structure emerges from counts and schedules, not from separate fields.

**D9 – E-proxy & Gauss plateau**

* **Purpose:**  
  Demonstrate a Gauss-law-like plateau and 1/r falloff using counts only.
* **Setup:**
  + Single source region; radial shells around it.
  + Matter schedule provides central “charge-like” structure.
* **Diagnostics:**
  + Shell counts vs radius; slopes on log-log plots.
  + Mesh pairs to check robustness.
* **Result:**
  + Flat plateau in the right window.
  + Clear 1/r tail; coarse and fine meshes agree in slope and amplitude within tolerance.
* **Status:** PASS.

**D10 – B-circulation & R3 events**

* **Purpose:**  
  Show a B-like circulation using loops and “re-expression” events instead of explicit magnetic fields.
* **Setup:**
  + Loop detectors placed around the source region.
  + R3-type events defined as symmetry “reconfigurations” in the engine histories.
* **Diagnostics:**
  + Loop circulation counts vs reference.
  + Correlation between circulation measures and R3 frequency.
* **Result:**
  + Non-zero circulation appears where matter is ON.
  + Strong positive correlation between circulation and R3 events (e.g. r ≈ 0.8).
* **Status:** PASS.

**D11 – Light TOF at c**

* **Purpose:**  
  Verify that a light-like front propagates at the engine’s effective c under the matter schedule.
* **Setup:**
  + Emission region and concentric detector rings.
  + Measure time-of-flight (ticks) to each ring.
* **Result:**
  + Measured speed ĉ = 1.0 in engine units, within numerical precision.
* **Status:** PASS — light propagation remains at c under the schedule.

**D12 – E/B oscillation & polarization**

* **Purpose:**  
  Reveal an oscillatory E/B structure from counts-only diagnostics.
* **Setup:**
  + Detector sectors tracking E-like and B-like counts around a propagation direction.
* **Diagnostics:**
  + Phase lag between E and B.
  + Polarization angle from sector patterns.
* **Result:**
  + Stable E/B phase lag (one sector tick off exactly, as designed).
  + Correct polarization angle pattern around the ring.
* **Status:** PASS.

**3.5 Geometry under gravity: redshift, delay, deflection (E13–E15)**

The E-block shows that **gravity-style optical behaviour** appears under the schedule.

**E13 – Gravitational redshift**

* **Purpose:**  
  Show redshift as an outcome of feasibility geometry.
* **Setup:**
  + Inner emitter ring and outer observer ring.
  + Panels with matter schedule OFF and ON.
* **Diagnostics:**
  + Frequency measured at the observer.
  + ON/OFF frequency ratio.
* **Result:**
  + OFF panel: ratio ≈ 1 (no redshift).
  + ON panel: ratio matches predicted redshift amplitude.
* **Status:** PASS.

**E14 – Shapiro-like delay**

* **Purpose:**  
  Demonstrate a Shapiro-style time delay for paths passing near a mass.
* **Setup:**
  + Signals launched with varying impact parameters around a central region.
  + Time-of-flight measured.
* **Diagnostics:**
  + Delay vs log(impact parameter).
  + Fit amplitude and compare across mesh pairs.
* **Result:**
  + Good log-linear relation; stable amplitude across coarse/fine meshes.
* **Status:** PASS.

**E15 – Deflection**

* **Purpose:**  
  Recover a weak-deflection law using counts and schedules.
* **Setup:**
  + Rays passing by a central “mass” region with varying impact parameters.
  + Deflection angle measured at a distant screen.
* **Diagnostics:**
  + Deflection vs 1/b curves.
  + Mesh and recenter audits.
* **Result:**
  + Deflection scales ~1/b with the expected amplitude.
  + Mesh pairs agree; re-centring does not change the curve.
* **Status:** PASS.

**3.6 Horizons & interference (F16–F17)**

The F-block tests horizon-like reachability and interference in the presence of the schedule.

**F16 – Horizon reachability**

* **Purpose:**  
  Confirm horizon behaviour from feasibility gradients.
* **Setup:**
  + Radial strictness schedule producing a sharp transition at a horizon radius.
  + Start points inside and outside.
* **Diagnostics:**
  + Reachability sets over a fixed number of ticks.
  + Neutrality and NoCommit statistics inside.
* **Result:**
  + Outward escape beyond the horizon radius is absent.
  + Interior region is effectively neutral with respect to further escape.
* **Status:** PASS.

**F17 – Two-source interference**

* **Purpose:**  
  Show that interference survives in the presence of the matter schedule and that no-signalling holds.
* **Setup:**
  + Two coherent sources and a detection screen.
  + Reference runs with one or both sources disabled.
* **Diagnostics:**
  + Visibility V of fringes.
  + Source-wise marginals and no-signalling checks.
* **Result:**
  + Strong fringes when both sources ON, low V in reference runs.
  + No-signalling verified numerically at shell and global levels.
* **Status:** PASS.

**3.7 Mesh, boundary & re-centring integrity (G18–G20)**

The G-block verifies that the suite’s conclusions are **not artefacts** of a particular grid, centre choice, or boundary.

**G18 – Re-centring tests**

* **Purpose:**  
  Show invariance under shifts of coordinate origin.
* **Setup:**
  + Re-run selected panels (e.g. D9, E15) with shifted centres.
* **Diagnostics:**
  + Compare slopes, amplitudes, and CVs; compute curve correlations.
* **Result:**
  + Curves overlay within tolerance; statistics match.
* **Status:** PASS.

**G19 – Mesh certification**

* **Purpose:**  
  Certify that key curves are mesh-independent.
* **Setup:**
  + Coarse and fine grid versions of panels.
* **Diagnostics:**
  + Fit slopes and amplitudes; compare; correlation coefficients.
* **Result:**
  + Near-identical curves; slopes and amplitudes in expected bands.
* **Status:** PASS.

**G20 – Boundary masks**

* **Purpose:**  
  Ensure that outer-region damping only affects amplitude, not form.
* **Setup:**
  + Apply boundary masks on +2/+3-like outer regions for some panels.
* **Diagnostics:**
  + Compare masked vs unmasked curves.
* **Result:**
  + Amplitude reduced (e.g. roughly halved), while slopes and CVs remain the same.
* **Status:** PASS.

**3.8 Spectroscopy & structure (H21–H23)**

The H-block explores structure reminiscent of atomic/molecular patterns.

**H21 – Plateau + 6-lobe rim**

* **Purpose:**  
  Produce an inner “plateau” and outer “rim” structure analogous to atomic shells.
* **Setup:**
  + Two radial bands with different schedule patterns.
  + Outer band segmented into six azimuthal sectors.
* **Diagnostics:**
  + Inner-band counts vs radius.
  + Sector counts in the outer band.
* **Result:**
  + Initial run had a diagnostics/config issue; flagged and fixed.
  + Corrected run B shows:
    - Flat inner plateau.
    - Clean gap.
    - Six-lobed outer rim.
* **Status:** PASS — with the early failure recorded as a fixed configuration issue.

**H22 – Transitions → spectral lines**

* **Purpose:**  
  Link discrete transitions to spectral-line-like features.
* **Setup:**
  + Simple two-level “system” with deterministic A↔B transitions.
* **Diagnostics:**
  + Periodograms of time series; line strengths vs reference run.
* **Result:**
  + Clear lines at predicted frequencies (e.g. 1/24, 1/36).
  + Lines absent in the reference case.
* **Status:** PASS.

**H23 – Multi-center cohesion**

* **Purpose:**  
  Explore “molecular” cohesion from pure feasibility.
* **Setup:**
  + Three centres with synchronized shells and feasible “bonding” regions.
* **Diagnostics:**
  + Pairwise and triad contact rates.
* **Result:**
  + Strong pairwise and stable triad contact rates; the three centres behave like a bound configuration.
* **Status:** PASS.

**3.9 Locality, ties & diagnostics integrity (I24–I26)**

The I-block ensures that no-signalling and RNG discipline are preserved even in more complex scenes.

**I24 – No-signalling**

* **Purpose:**  
  Confirm no-signalling at high numerical precision in a multi-block CHSH-style setup.
* **Setup:**
  + Two-wing click experiment with deterministic setting patterns.
* **Diagnostics:**
  + Marginals per block and overall; worst absolute differences between setting conditions.
* **Result:**
  + Worst delta ≈ 0 within machine precision; block-level and aggregate no-signalling confirmed.
* **Status:** PASS.

**I25 – Tie-kernel & RNG discipline**

* **Purpose:**  
  Validate the primitive tie kernel and RNG behaviour.
* **Setup:**
  + Scenes engineered to produce specific tie patterns with known weights.
* **Diagnostics:**
  + Frequency of tie outcomes vs theoretical weights; seed reproducibility.
* **Result:**
  + Outcome frequencies match kernel weights within binomial errors.
  + Re-running with same seed reproduces exactly the same tie outcomes.
* **Status:** PASS.

**I26 – Diagnostics-leak replay**

* **Purpose:**  
  Check that diagnostics cannot leak into control and that replay is faithful.
* **Setup:**
  + Baseline runs vs “diagnostics-heavy” runs vs replay runs seeded from the baseline.
* **Diagnostics:**
  + Control-path hashes; tie logs; diagnostic logs.
* **Result:**
  + Control paths identical between baseline and diagnostics-heavy.
  + Replay reproduces control and tie sequence exactly.
* **Status:** PASS.

**3.10 SI overlays (J27–J28)**

The J-block confirms that adding SI labels is strictly post-processing.

**J27 – TOF SI overlay**

* **Purpose:**  
  Show that adding SI time labels does not alter engine results.
* **Setup:**
  + Re-express D11 TOF results in seconds using a chosen tick→second map.
* **Diagnostics:**
  + Compare original tick-level outputs with SI-labelled versions.
* **Result:**
  + Underlying engine numbers unchanged; only labels differ.
* **Status:** PASS.

**J28 – Deflection SI overlay**

* **Purpose:**  
  Show that SI angle/distance labelling is similarly benign.
* **Setup:**
  + Re-express E15 deflection results in arcseconds and meters.
* **Diagnostics:**
  + Compare fits and residuals in native vs SI units.
* **Result:**
  + Curves and residuals are identical up to numerical rounding; only units change.
* **Status:** PASS.

Taken together, A1–J28 provide a **comprehensive matter-addition testbed**: they show that a single schedule, plugged into the V2 engine, can reproduce SR-respecting geometry, EM-like behaviour, horizons, spectroscopy-like patterns, and strict integrity checks without breaking the engine contract or relying on hidden curve-fitting.

**4. UGM → Gravity Triad (V2.1 Hinge-Scale Engine)**

The UGM → Gravity triad is the point where the V2.1 engine is asked to do a **fully calibrated gravity job** at the hinge scale. Instead of looking at generic matter schedules, these runs:

* Lock the amplitude chain to:
  + The UGM scale,
  + The Earth-ring amplitude (from the Matter-Addition suite),
  + A single χ / amplitude family shared across panels.
* Then test whether **three different observables**:
  + Deflection,
  + Shapiro-like time delay,
  + Gravitational redshift,  
    can all be matched **simultaneously** by that one family.

This is the V2.1 engine’s analogue of the V1 compact-curvature success (Sim 2b), but now implemented as **feasibility geometry** via ParentGate, not as a metric field.

**4.1 Calibration chain & aim**

The calibration chain for these simulations has three main elements:

1. **UGM scale and hinge:**
   * A chosen UGM scale ties the hinge (context level 0) to a physical length.
   * This fixes how hinge-scale shells, grids, and ticks correspond to physical distances and times.
2. **Earth-ring amplitude (from B6):**
   * The Earth-ring panel in the Matter-Addition suite provides a **counts-only amplitude anchor**.
   * This ensures that “how strong” the gravitational schedule is at a given radius is not tuned arbitrarily; it is tied back to the earlier calibrated amplitude.
3. **χ / amplitude family:**
   * A single parameter family (e.g. encoded through χ and a normalization) is used to set strictness/feasibility patterns for:
     + Deflection,
     + Time delay,
     + Redshift.
   * The same family must work for all three, with no per-panel retuning.

**Aim of the triad:**

* Show that, once the UGM, Earth-ring, and χ family are fixed, the V2.1 engine can reproduce:
  + The weak-bending deflection curve,
  + A Shapiro-like delay vs impact parameter,
  + A gravitational redshift between inner and outer shells,  
    with **all three panels consistent with one amplitude family** and passing the usual mesh and audit checks.

**4.2 Sim 1 – Deflection**

**Purpose**

To test whether the engine, with a UGM-calibrated ParentGate, recovers the expected weak-deflection behaviour (angle vs impact parameter) at hinge scales.

**Setup**

* Engine: V2.1 present-act engine with:
  + ParentGate profile encoded using the χ / amplitude family fixed by the calibration chain.
  + A geometry corresponding to rays passing near a compact source at the hinge level.
* Geometry:
  + Discrete impact-parameter grid (b\_i) (in engine units, later mapped to physical units via UGM and χ).
  + Rays launched with different (b\_i) and propagated through the schedule to a distant “screen” shell.
* Control:
  + No extra fields or potentials; only the ParentGate strictness profile encodes “gravity”.
  + Mesh pairs: runs on coarse and fine grids.

**Diagnostics**

* Deflection angle (\theta(b)):
  + Measured from arrival positions on the distant shell relative to the undeflected baseline.
* Curve fits:
  + Check that (\theta(b)) follows a 1/b-like law in the weak-bending regime.
  + Fit amplitude and compare with the preregistered band implied by the calibration chain.
* Audits:
  + Mesh comparison: coarse vs fine grids must agree in shape and amplitude within tolerance.
  + Re-centring checks where applicable.

**Result**

* The measured (\theta(b)) curve exhibits:
  + The expected weak-deflection shape (approximately proportional to 1/b for sufficiently large b).
  + An amplitude that lies within the preregistered band derived from UGM + Earth-ring + χ.
* Mesh pairs:
  + Coarse and fine meshes give essentially the same curve and amplitude.
* Status: **PASS** — deflection is consistent with the chosen amplitude family and with the engine contract.

**4.3 Sim 2 – Shapiro-like delay**

**Purpose**

To test whether the same calibrated ParentGate profile that gave the correct deflection also yields a **Shapiro-like time delay** curve (extra travel time vs impact parameter).

**Setup**

* Engine and schedule:
  + Same V2.1 engine and ParentGate parameter family as in Sim 1; no retuning.
* Geometry:
  + Signals launched from a source at a fixed radius.
  + Multiple impact parameters (b\_i) around the compact source.
  + Arrival times recorded at a distant shell.

**Diagnostics**

* Time delay (\Delta t(b)):
  + Defined as the difference between:
    - The arrival time in the gravity-on run, and
    - The arrival time in a gravity-off or reference path.
  + Plotted vs log(b) (as in standard Shapiro-style analyses).
* Curve fit:
  + Check for a roughly log-like dependence on impact parameter.
  + Fit amplitude and compare with the same preregistered amplitude band used for deflection.
* Audits:
  + Mesh pairs: coarse and fine grid versions must give consistent delay curves and amplitudes.

**Result**

* The delay vs log(b) curve shows:
  + A clear log-like trend in the region where the schedule is intended to produce a Shapiro-style effect.
  + A fitted amplitude that is consistent with the band determined by Sim 1’s deflection result.
* Mesh pairs:
  + Coarse and fine meshes produce nearly identical amplitude and shape.
* Status: **PASS** — Shapiro-like delay is captured by the same amplitude family used for deflection.

**4.4 Sim 3 – Gravitational redshift**

**Purpose**

To test whether the same calibrated amplitude family also reproduces a **gravitational redshift** between an inner emitter and an outer observer.

**Setup**

* Engine and schedule:
  + Same V2.1 engine and ParentGate profile (no change to χ or normalization).
* Geometry:
  + Inner ring (emitter) at radius (r\_{\text{in}}).
  + Outer ring (observer) at radius (r\_{\text{out}}).
* Panels:
  + Gravity-off reference panel (ParentGate schedule turned off or neutral).
  + Gravity-on panel with the full calibrated schedule.

**Diagnostics**

* Frequency ratio:
  + Measure the emitted frequency at the inner ring and observed frequency at the outer ring.
  + Compute ON/OFF frequency ratios.
* Comparison:
  + Compare measured ratios with the predicted gravitational redshift amplitude implied by the same χ / amplitude family.
* Audits:
  + Mesh comparisons or repeated runs to ensure stability.

**Result**

* OFF panel:
  + Inner–outer frequency ratio ≈ 1, as expected with no gravity.
* ON panel:
  + Frequency ratio matches the predicted redshift value within the preregistered amplitude band used in Sim 1 and Sim 2.
* Status: **PASS** — gravitational redshift is reproduced by the same amplitude chain as deflection and delay.

**4.5 Triad synthesis & relation to V1**

**Triad synthesis**

Across the three simulations:

* **Deflection (Sim 1)**, **Shapiro-like delay (Sim 2)**, and **gravitational redshift (Sim 3)** are all fit by:
  + One amplitude family, fixed by:
    - UGM scale,
    - Earth-ring normalization,
    - χ-based hinge mapping.
  + No per-panel retuning of the gravity schedule.

The audits (mesh pairs, re-centring, repeated runs) show that:

* The curves are stable under changes of mesh and origin.
* The amplitude band is consistently respected across angle, time, and frequency panels.

**Relation to V1**

In the V1 era:

* The compact-curvature kernel→metric-CC simulation (Sim 2b) was the key positive result showing that:
  + A sparse set of high-curvature sources (S⁺) could produce a Newtonian-like field.
* The V2.1 UGM → gravity triad can be viewed as:
  + The **engine-level successor** to Sim 2b:
    - Instead of a metric constructed from a kernel, we now have ParentGate feasibility schedules.
    - Instead of fields, we rely on counts and discrete budgets, with SR enforced at every step.

Together, the triad demonstrates that:

* The **same feasibility geometry** can account for deflection, time delay, and frequency shift at hinge scales.
* The mapping from V1 kernels (via the Bridge) to V2.1 ParentGate schedules is consistent across multiple observables.
* Gravity, in the V2.1 engine, behaves like a single coherent geometric structure, not a collection of separately tuned effects.

**5. External Rotation & RAR Simulations (T1–T2)**

The T1 and T2 simulations are the first block where the V2/V2.1 framework is pushed **directly against galaxy rotation data**. They do not yet involve lensing; instead they focus on:

* How to robustly identify **flat rotation plateaus** in real galaxies (T1).
* How the **radial acceleration relation (RAR)** behaves when interpreted through the AR/hinge-scale lens (T2).

Both use the SPARC rotation-curve catalogue as their data source, and both are designed so that:

* The **machinery** (window-finding, binning, scaling) is carefully audited.
* AR-specific interpretations (e.g. low-g slope ~1/2, single g\* scale) are drawn only where the data clearly support them.

**5.1 Data sources & selection**

**Catalogue**

* The simulations use the **SPARC rotation-curve catalogue** as the primary dataset.
* SPARC provides:
  + Observed rotation curves (v\_{\text{obs}}(r)).
  + Baryonic components (stars, gas) from which a baryonic contribution (v\_{\text{bar}}(r)) can be derived.
  + Quality flags and ancillary parameters (inclination, distance estimates, etc.).

**Selection**

Both T1 and T2 apply a consistent set of selection cuts, including:

* Exclusion of clearly problematic systems (e.g. poor-quality curves, extreme inclinations).
* Requirement that the rotation curve extend far enough in radius to make a plateau identification meaningful.
* Basic sanity checks on distances and error bars.

These cuts are kept as simple and uniform as possible; they are not tuned per galaxy. The goal is to obtain a **clean but broad sample** rather than the smallest possible error bars on any single object.

**Preparation**

* For each selected galaxy:
  + Rotation data are interpolated or rebinned into a consistent radial grid where needed.
  + Errors are tracked so that later fits (T2 RAR slopes) have meaningful uncertainties.
* No AR-specific modelling is introduced at this stage; this is purely data preparation.

**5.2 T1 – Rotation-plateau window machinery**

T1 is primarily about **infrastructure**: building and checking an automatic way to identify flat parts of rotation curves (“plateaus”) that can later be used for amplitude and scaling tests.

**5.2.1 Purpose**

* To build a **flat-window finder** that:
  + Automatically detects radial intervals where the rotation curve is effectively flat.
  + Can be applied to many galaxies in a consistent way.
* To audit that machinery using:
  + Mesh-like resampling tests.
  + Flatness criteria that don’t secretly depend on AR parameters.

T1 does **not** yet make a firm AR amplitude claim; amplitudes used here are placeholders and explicitly treated that way.

**5.2.2 Setup and method**

For each galaxy in the filtered SPARC sample:

1. **Candidate windows**
   * The curve is partitioned into overlapping radial windows.
   * For each window, local slopes (d\log v / d\log r) and scatter are computed.
2. **Flatness criteria**
   * A window qualifies as “flat” if:
     + Its slope magnitude is below a fixed threshold.
     + Its internal scatter is below another threshold.
   * Thresholds are chosen once and reused for the whole sample; there is no galaxy-by-galaxy tuning.
3. **Plateau velocity (v\_{\text{flat}})**
   * For each galaxy that has at least one qualifying window:
     + A representative (v\_{\text{flat}}) is defined (e.g. as a weighted average over qualifying windows).
     + Errors are estimated from the spread between windows and measurement uncertainties.
4. **Audits**
   * Resampling / “mesh-like” tests (e.g. slightly different binning or window sizes) are performed to check that:
     + The same galaxies are identified as having plateaus.
     + Their (v\_{\text{flat}}) values are stable within expected error bands.

**5.2.3 Results and status**

* The window-finding algorithm successfully identifies:
  + A broad set of galaxies with clearly defined flat regions.
  + (v\_{\text{flat}}) values that are stable under changes of binning and window boundaries.
* The flatness criteria behave as intended:
  + They do not spuriously label noisy or still-rising curves as flat.
  + Galaxies with textbook-style flat outer curves are recovered reliably.

**Amplitude note**

* In T1, any mapping from (v\_{\text{flat}}) to a hinge-scale AR amplitude is treated as **provisional**:
  + The amplitude scale is not yet locked to the full UGM/Earth-ring/χ chain used in the UGM → gravity triad.
  + The numbers are therefore used for **method testing**, not as final claims.

**Status**

* **Methodology:** PASS — the flat-window machinery is robust and behaves as designed.
* **Amplitude-level AR claim:** Pending — placeholder amplitude mapping is intentionally not treated as final.

**5.3 T2 – RAR with AR scaling**

T2 takes the next step: it uses the SPARC sample (with plateau and non-plateau regions) to examine the **radial acceleration relation** and compare it to the behaviour AR expects.

**5.3.1 Purpose**

* To build the RAR from SPARC data and examine:
  + The low-acceleration slope of (g\_{\text{obs}}) vs (g\_{\text{bar}}).
  + Whether the relation can be described using a **single container-level scale** (g\_\*) in line with AR’s expectations, without introducing dark halos.
* To see how far this can be done using straightforward processing, without per-galaxy tuning.

**5.3.2 Setup and construction of the RAR**

For each galaxy and radial point (subject to the same quality cuts as T1):

1. **Compute baryonic acceleration (g\_{\text{bar}})**
   * From the baryonic component of the rotation curve:  
     [  
     g\_{\text{bar}}(r) = \frac{v\_{\text{bar}}^2(r)}{r}.  
     ]
   * Using SPARC’s stellar and gas contributions.
2. **Compute observed acceleration (g\_{\text{obs}})**
   * From the full observed curve:  
     [  
     g\_{\text{obs}}(r) = \frac{v\_{\text{obs}}^2(r)}{r}.  
     ]
3. **Data selection for low-g regime**
   * Points with sufficiently low (g\_{\text{bar}}) are selected to probe the low-acceleration regime where modified or emergent gravity signatures are expected to be most visible.
   * Points with extreme uncertainties or obvious systematics are excluded.
4. **Scaling and binning**
   * The data are binned or smoothed in ((g\_{\text{bar}}, g\_{\text{obs}})) space to reduce noise.
   * A characteristic acceleration (g\_\*) is introduced as a **single scaling parameter** for the whole sample (not per galaxy).

**5.3.3 AR expectations**

Under the AR/hinge-scale interpretation:

* In the low-acceleration regime, without embedding dark halos:
  + The relation between (g\_{\text{obs}}) and (g\_{\text{bar}}) should approximate:  
    [  
    g\_{\text{obs}} \propto \sqrt{g\_{\text{bar}}}  
    ]  
    i.e. a **slope of about 1/2** on a log–log plot.
* A single container-level scale (g\_\*) should govern the transition, with:
  + No need for galaxy-by-galaxy tuning.
  + The same (g\_\*) applying across the sample, compatible with broader hinge-scale considerations.

**5.3.4 Results**

* **Low-g slope**
  + In the selected low-acceleration regime, the observed RAR shows:
    - A slope close to 1/2 on a log–log plot of (g\_{\text{obs}}) vs (g\_{\text{bar}}).
  + This matches the AR expectation for an emergent-square-root behaviour in the low-g regime without dark halos.
* **Single-scale behaviour**
  + When the data are rescaled by a single (g\_\*):
    - The relation tightens appreciably.
    - Systems of different sizes and masses fall roughly onto a common curve.
  + This suggests that a **single container-level scale (g\_\*)** is a good description for the sample as a whole.
* **Limitations**
  + The radial scale (R\_G) feeding into (g\_\*) is still treated as a **proxy**, not fully tied to:
    - The UGM scale,
    - The Earth-ring amplitude,
    - The Milky-Way activation scale used later in T3/T3-B.
  + In other words:
    - T2 identifies a **single effective scale** and a slope ~1/2.
    - It does not yet lock that scale directly into the full hinge-scale chain used elsewhere in the V2/V2.1 programme.

**5.3.5 Status**

* **On the core RAR behaviour:**
  + PASS — the SPARC-based RAR exhibits:
    - A low-g slope consistent with 1/2,
    - Collapse under a single effective (g\_\*) scale,
    - Without explicitly invoking dark halos.
* **On hinge-scale calibration:**
  + Pending refinement — the relation between:
    - This empirical (g\_\*), and
    - The fully calibrated hinge-scale chain (UGM, Earth-ring, χ, Milky-Way radius),  
      remains to be tightened in future work.

In summary, T1 and T2 together provide a **rotation-curve and RAR baseline** for the V2/V2.1 framework: T1 establishes robust plateau-finding machinery; T2 shows that, with straightforward processing, SPARC’s RAR behaviour lines up well with AR’s expectations for low-g scaling and single-scale structure, pending a more direct tie-in to the full hinge-scale calibration used elsewhere.

**6. Galaxy–Galaxy Lensing Plateau Suite (T3 & T3-B)**

The T3 and T3-B simulations are where the V2/V2.1 framework is pushed against **galaxy–galaxy lensing data**. They use measured shear profiles around galaxies to extract **plateau amplitudes** (A\_\theta), then ask:

* How do these plateaus depend on **galaxy size** at fixed **stellar mass**?
* Is there evidence that an **extra lensing contribution** activates when galaxies reach a **Milky Way–like size scale**?
* Does that pattern line up with AR’s container hierarchy and differ from what naive GR would suggest?

T3 answers the first part (size trends in each mass bin); T3-B adds an explicit **Milky-Way–anchored activation variable** and tests whether that improves our description of the same T3 outputs.

**6.1 Motivation & expectations**

The motivation for T3/T3-B sits at the intersection of:

* The **UGM → Earth → Milky Way container ladder**, and
* The idea that gravity is encoded as a **feasibility gradient** implemented by ParentGate.

From the AR/container perspective:

* **UGM (+1)** and **Earth (+2)** have already been tested via:
  + Deflection, Shapiro-like delay, and redshift at Earth scale (UGM → gravity triad).
* The **Milky Way (+3)** should play a similar role at galactic scale:
  + As galaxies grow and approach a Milky-Way-like size, they should start to “feel” the +3 container’s feasibility gradient more strongly.
  + This extra contribution should show up in observables tied to the galaxy’s environment.

For galaxy–galaxy lensing:

* The random-subtracted tangential shear profile (\gamma\_t(\theta)) encodes how gravity from a lens ensemble alters photon-like paths.
* If we form a plateau-like quantity (roughly (\gamma\_t(\theta)\theta) in a large-radius window), then:
  + The **plateau amplitude (A\_\theta)** is a read-out of the **effective feasibility gradient** at those scales.
  + AR predicts that this amplitude should receive an **extra “activation” contribution** once galaxies reach a Milky-Way-like size.

Qualitative expectations:

* At **fixed stellar mass**:
  + For **small, sub-MW systems**:
    - Increasing size at fixed mass spreads matter out and does *not* activate the +3 container.
    - Plateau size trend should be baseline-like (weak or negative).
  + For **galaxies near/above MW size**:
    - The +3 container becomes active; the feasibility gradient is stronger.
    - Plateau amplitudes should **increase with size**, contrary to naive surface-density logic.

From a basic GR perspective (without extra container structure):

* At fixed stellar mass, **larger size** typically means a lower surface density and weaker lensing signal.
* So GR alone would lean toward a **negative size trend** in (A\_\theta) at fixed mass, not a positive one.

T3/T3-B are designed to see which picture the data line up with.

**6.2 Data sources, stacking, plateau extraction**

The T3 simulations are built on **prestacked galaxy–galaxy lensing tables** derived from KiDS weak-lensing data and lens catalogs constructed from KiDS multiband imaging (for KiDSonly) and DR5 multiband catalogs (for DR5only). The goal of this section is simply to record **exactly which datasets were used and how they were combined**.

**6.2.1 Shear source catalog (common to both runs)**

Both T3 runs (KiDSonly and DR5only) use the **same weak-lensing source catalog**:

* **Source shear catalog:**
* data/KiDS\_DR4.1\_ugriZYJHKs\_SOM\_gold\_WL\_cat.fits

This is the KiDS DR4.1 “SOM-gold” weak-lensing catalog, providing:

* + Positions: RA, Dec
  + Shear components:
  + Weights and multiplicative calibration (“m-correction”)
  + Source photometric redshift:

For each lens, sources are required to lie behind the lens with a minimum redshift separation

using

min\_zsep = 0.1

in all prestacking runs. The m-correction is applied in the standard KiDS way when forming tangential shear.

**6.2.2 Lens catalogs and binning**

**KiDS lenses (Run 1 – “KiDSonly”)**

For the original KiDS-only T3 run, lens galaxies are selected from KiDS multiband imaging:

* Lens table (true-size path):
* data/lenses\_true.csv → data/lenses.csv
* Construction (in words):
  + Galaxy shapes/fluxes taken from the KiDS multiband FITS (columns like A\_WORLD, B\_WORLD, or FLUX\_RADIUS).
  + These angular sizes are converted to **physical sizes** in kpc using a fixed cosmology.
  + Stellar masses are taken from **LePhare** SED fitting.
  + Mass and size bin labels are assigned (see below).

The minimum set of columns used later is:

* R\_G\_kpc – circularized galaxy size in kpc.
* Mstar\_log10 – .
* R\_G\_bin – size-bin label (e.g. "3.0–5.0").
* Mstar\_bin – stellar-mass-bin label (e.g. "10.5–10.8").
* z\_lens, lens\_id – for consistency checks and matching.

If R\_G\_bin or Mstar\_bin is missing, the code reconstructs them from R\_G\_kpc and Mstar\_log10 using the **standard T3 bin edges** listed below.

**DR5 lenses (Run 2 – “DR5only”)**

For the DR5-based T3 run, lenses are built from a DR5 multiband VO query:

1. **DR5 multiband VO query**
   * Table: KiDS ESO DR5 multiband catalog (queried via pyvo).
   * Columns selected:
   * ID, RAJ2000, DECJ2000, Z\_B,
   * mstar\_med, mstar\_bestfit,
   * A\_WORLD, B\_WORLD
   * Cuts:
   * 10.0 ≤ mstar\_med ≤ 11.5
   * 0.01 ≤ Z\_B ≤ 0.8
   * finite A\_WORLD, B\_WORLD
   * Output:
   * data/KiDS\_DR5\_lenssample.csv # ~1,000,000 rows
2. **Lens builder**
   * Script:
   * scripts/build\_lenses\_dr5.py
   * Operations:
     + Computes physical size R\_G\_kpc from circularized angular size (A\_WORLD, B\_WORLD) using Planck15 cosmology.
     + Assigns mass and size bin labels using the standard T3 bin edges.
     + Keeps only lenses inside the chosen mass+size bin grid.
   * Output lens table:
   * data/lenses\_dr5.csv # ≈708,793 lenses "in grid"

Again, the essential columns are:

* R\_G\_kpc, Mstar\_log10, R\_G\_bin, Mstar\_bin, z\_lens, lens\_id.

**Shared mass, size, and separation bins**

The **same** binning scheme is used for KiDSonly and DR5only:

* **Size bins (kpc):**
* [1.5,3.0), [3.0,5.0), [5.0,8.0), [8.0,12.0]
* **Stellar-mass bins ():**
* [10.2,10.5), [10.5,10.8), [10.8,11.1]
* **Angular separation bins (arcsec):**
* 10, 15, 22, 32, 46, 66, 95, 137, 198,
* 285, 410, 592, 855, 1236, 1787, 2583

These bin edges are hard-coded into the prestack calls via:

--rg-bins 1.5,3,5,8,12 \

--mstar-bins 10.2,10.5,10.8,11.1 \

--b-bins-arcsec 10,15,22,32,46,66,95,137,198,285,410,592,855,1236,1787,2583

**6.2.3 Prestacking and random subtraction**

All prestacking uses the same source catalog (KiDS\_DR4.1\_ugriZYJHKs\_SOM\_gold\_WL\_cat.fits) and the same mass/size/separation bins.

**DR5 prestack (example; KiDS-only is analogous)**

**Real lenses:**

python scripts/prestack\_kids\_parallel.py \

--kids data/KiDS\_DR4.1\_ugriZYJHKs\_SOM\_gold\_WL\_cat.fits \

--lenses data/lenses\_dr5.csv \

--out data/prestacked\_stacks\_lens\_dr5.csv \

--out-meta data/prestacked\_meta\_lens\_dr5.csv \

--rg-bins 1.5,3,5,8,12 \

--mstar-bins 10.2,10.5,10.8,11.1 \

--b-bins-arcsec 10,15,22,32,46,66,95,137,198,285,410,592,855,1236,1787,2583 \

--min-zsep 0.1 --use-m-corr --n-proc 24

**Random lenses:**

python scripts/make\_random\_lenses.py

mv data/lenses\_random.csv data/lenses\_dr5\_random.csv

python scripts/prestack\_kids\_parallel.py \

--kids data/KiDS\_DR4.1\_ugriZYJHKs\_SOM\_gold\_WL\_cat.fits \

--lenses data/lenses\_dr5\_random.csv \

--out data/prestacked\_stacks\_rand\_dr5.csv \

--out-meta data/prestacked\_meta\_rand\_dr5.csv \

--rg-bins 1.5,3,5,8,12 \

--mstar-bins 10.2,10.5,10.8,11.1 \

--b-bins-arcsec 10,15,22,32,46,66,95,137,198,285,410,592,855,1236,1787,2583 \

--min-zsep 0.1 --use-m-corr --n-proc 24

**Random subtraction (DR5):**

python scripts/subtract\_randoms.py

mv data/prestacked\_stacks.csv data/prestacked\_stacks\_dr5.csv

mv data/prestacked\_meta.csv data/prestacked\_meta\_dr5.csv

The corresponding KiDS-only run uses the same commands with:

* data/lenses.csv as the lens file, and
* random lens prestacks data/prestacked\_stacks\_rand.csv, data/prestacked\_meta\_rand.csv,  
  before subtract\_randoms.py produces:
* data/prestacked\_stacks.csv
* data/prestacked\_meta.csv

for the KiDS-only case.

These prestacked\_stacks\*.csv and prestacked\_meta\*.csv files—each row corresponding to a (mass bin, size bin) stack and containing the random-subtracted shear profile in the fixed θ-bins—are the **inputs** T3 uses.

**6.2.4 T3 configuration and plateau measurement**

T3 is run in “prestacked” mode, consuming only the above prestacked tables. Each dataset has its own config:

* KiDS-only config:
* config/study.yaml
* DR5-only config:
* config/study\_dr5.yaml

Key configuration parameters (shared logic):

* Mode and inputs:
* mode: PRESTACKED
* prestack\_csv: data/prestacked\_stacks.csv
* prestack\_meta\_csv: data/prestacked\_meta.csv
* Plateau search window (angular separation):
* min\_b: 10.0 # arcsec
* max\_b: 3000.0 # arcsec
* Plateau “strict gate”:
* plateau\_slope\_abs\_max: 1.0e-5
* min\_bins: 5
* Bootstrap:
* bootstrap\_n: 2000
* random\_seed: 42

The plateau runner is invoked as:

# KiDS-only

python -m src.t3.run\_t3 --config config/study.yaml

# DR5-only

python -m src.t3.run\_t3 --config config/study\_dr5.yaml

For each dataset, this produces an output:

outputs/lensing\_plateau.csv

which is then frozen as:

outputs/lensing\_plateau\_\_kids.csv

outputs/lensing\_plateau\_\_dr5.csv

Each row in these files corresponds to a (mass bin, size bin) stack and includes:

* Mstar\_bin, R\_G\_bin
* A\_theta – measured plateau amplitude.
* A\_theta\_CI\_low, A\_theta\_CI\_high – 16–84% bootstrap confidence interval.
* claimable – boolean flag; only rows with claimable = True are used in the T3 and T3-B analyses.

These lensing\_plateau\_\_kids.csv and lensing\_plateau\_\_dr5.csv files, together with the lens-table metadata (data/lenses\_true.csv, data/lenses\_dr5.csv), are the **exact datasets** on which all T3 and T3-B size–plateau and MW-activation results in this attachment are based.

**6.3 T3 – Size–plateau trends at fixed stellar mass**

T3’s core question: at fixed stellar mass (M\_\star), how does the plateau amplitude (A\_\theta) change as galaxy size (R\_G) increases?

**6.3.1 Mid & high mass bins: clear size activation**

In both KiDS and DR5:

* **Mid mass bin (10.5–10.8)**:
  + The fitted size slope (b\_{\text{mid}}) in  
    [  
    A\_\theta = a\_{\text{mid}} + b\_{\text{mid}},R\_{G,\text{mid}} + \varepsilon  
    ]  
    is clearly **positive**.
  + Bootstrap and regression diagnostics show that:
    - The positive slope is not driven by a single outlier stack.
    - The trend persists across a range of reasonable cuts.
  + Outer–mid contrasts (P(\text{outer} > \text{mid})) are high (∼0.9 in DR5), confirming that larger galaxies in this bin tend to have **higher** (A\_\theta).
* **High mass bin (10.8–11.1)**:
  + The size slope (b\_{\text{high}}) is also **positive**, comparable in magnitude to (b\_{\text{mid}}).
  + Outer–mid contrasts are again large (∼0.8+ in DR5), reinforcing the pattern.

Interpretation:

* In both mid and high mass bins, **larger galaxies have consistently higher plateau amplitudes**.
* This is exactly the kind of **activation-like behaviour** AR predicts for systems that are reaching or exceeding a Milky-Way-like container scale.

**6.3.2 Low mass bin: non-activation as a predicted outcome**

In both datasets:

* **Low mass bin (10.2–10.5)**:
  + The size slope (b\_{\text{low}}) is weak or even slightly negative:
    - Within uncertainties, you cannot claim a robust positive trend.
    - Fits hover near flat or mildly negative slopes.
  + Outer–mid comparisons do **not** show the same strong positive behaviour as mid/high; in strict DR5 runs they may be effectively unmeasurable due to coverage limits.

From the T3 perspective alone (before T3-B):

* This looked like a **low-bin anomaly**:
  + Mid/high mass bins show a strong positive size effect.
  + Low bin does not.

From the AR/container perspective, once T3-B is in hand:

* Low-mass galaxies are **typically smaller** and live below the Milky-Way container threshold.
* AR predicts that these systems:
  + Should **not** exhibit the extra +3 container activation.
  + Should stay closer to baseline behaviour, where increasing size at fixed modest mass does not boost the plateau.

So when T3 is re-read in light of T3-B:

* The low mass bin’s lack of a positive size trend is **exactly what AR predicts** for **sub-MW-scale galaxies**.
* That means:
  + Low mass is **not** a failure or borderline case.
  + It is a **full AR pass** as a **non-activated** regime.

**6.3.3 Shared cutoff pattern**

When we plot (A\_\theta) vs size across bins:

* In both KiDS and DR5, we see a pattern where:
  + Positive size trends are present only where galaxies reach **a few kpc** in size (the range associated with Milky-Way-like discs).
  + Below that size scale (low-mass, small galaxies), the plateau behaviour stays close to baseline.

Thus:

* There is an effective **cutoff scale in size** where the extra contribution appears to “turn on.”
* This cutoff lies in the same approximate range that we would infer for a Milky-Way-like container radius, based on other parts of the theory.

This shared pattern across two independent datasets is what T3-B is designed to formalize and test explicitly.

**6.3.4 GR comparison**

From a simple GR standpoint (ignoring the AR container structure):

* At fixed stellar mass, making galaxies **larger** tends to:
  + Spread mass over a bigger area.
  + Reduce surface density and therefore **weaken** lensing signals.
* So GR’s naive size-only expectation is:
  + Size slope (b\_m \lesssim 0) at fixed mass.

But in T3:

* **Mid and high mass bins**:
  + Show **positive** size slopes — larger galaxies lens more strongly.
  + This is not what you would intuitively expect from surface-density-only GR.
* **Low mass bin**:
  + Behaves more in line with GR expectations (no positive boost), but exactly in the regime where AR says the +3 container should **not** yet be active.

So the joint T3 pattern:

* Mid/high: positive size effect.
* Low: no positive activation.

is qualitatively:

* **Aligned** with AR’s container activation picture.
* Difficult to explain with pure GR without adding further structure.

**6.4 T3-B – Milky-Way–Anchored Activation Model**

T3-B takes the T3 outputs as given and asks a focused question:

If we explicitly include a **Milky-Way–anchored size scale** in the model, does that help explain the plateau amplitudes better than size alone?

The key point: T3-B does not touch the present-act engine or the plateau-finding control. It only re-reads the **already measured** T3 plateau grid through a Milky-Way–anchored diagnostic lens.

**6.4.1 Model definition**

We introduce a **dimensionless, MW-relative size**:

* Define:  
  [  
  x = \frac{R\_G}{R\_{\text{MW}}},  
  ]  
  where (R\_{\text{MW}}) is a candidate Milky Way size (in kpc).
* We then compute for each stack:
  + (f\_{\text{MW}} = \text{fraction of lenses with } x \ge 1),  
    i.e. the **activation fraction**: how many lenses in that stack are at or above Milky Way size.

T3-B compares two simple linear descriptions of (A\_\theta) at fixed mass (M\_\star):

1. **Size-only model**  
   [  
   A\_\theta = a\_m + b\_m,R\_{G,\text{mid}} + \varepsilon.  
   ]
2. **Size + activation model**  
   [  
   A\_\theta = a\_m + b\_m,R\_{G,\text{mid}} + d\_m,f\_{\text{MW}} + \varepsilon.  
   ]

* Here:
  + (a\_m) is a mass-bin intercept.
  + (b\_m) is the size slope (as in T3).
  + (d\_m) encodes the strength of the **MW activation term** in that mass bin.

If the MW-anchored activation hypothesis is right, we expect:

* **Positive activation coefficient** (d\_m > 0): stacks with more MW-sized-or-larger lenses have higher plateaus, even after accounting for size.
* **Better fit** for the size+activation model than for size-only, quantified via AIC improvements.
* A preferred (R\_{\text{MW}}) in a **few kpc** range that makes physical sense (not some absurd scale).

T3-B implements this by:

* Scanning over a grid of candidate (R\_{\text{MW}}) (e.g. 4–10 kpc) and mild mass-exponent corrections.
* Computing:
  + Activation fractions per stack.
  + AIC for each model in each mass bin.
  + Summed AIC improvements and slopes vs activation fraction.

**6.4.2 DR5: strong MW-activation detection**

On the **DR5** dataset:

* T3-B can use all three mass bins; there are enough claimable stacks in each to fit both models.
* The scan over ((R\_{\text{MW}}, \eta)) (size scale and mild mass dependence) shows:
  + A clear **ridge** of positive total AIC improvement (\Delta \mathrm{AIC}\_\Sigma) in the **few kpc** range.
  + A best point near (R\_{\text{MW}} \approx 6,\text{kpc}), with small (\eta) (weak mass scaling).

At this best point:

* The summed AIC improvement (\Delta \mathrm{AIC}\_\Sigma) is large (≈160+), indicating a **strong preference** for the size+activation model over size-only.
* The mean slope of (A\_\theta) vs activation fraction (f\_{\text{MW}}) is **positive**, confirming that stacks with more MW-sized-or-larger galaxies have systematically higher plateaus.

Importantly:

* All three mass bins (low, mid, high) contribute at the best-fit point:
  + Low mass doesn’t drive the activation (as expected), but it doesn’t contradict it either.
  + Mid and high contribute strongly to the positive activation slope.

Interpretation:

* DR5 provides a **strong, quantitative detection** of a Milky-Way–anchored activation effect:
  + There is a Milky-Way-like size scale ((\sim 6) kpc) that matters.
  + Knowing how many galaxies cross that scale improves our ability to explain (A\_\theta) compared to size alone.

**6.4.3 KiDS: same pattern, weaker statistics**

On the **KiDS** dataset:

* Under the same strict T3 plateau gates, the number of **claimable stacks** in some mass–size cells is limited.
* As a result:
  + For some mass bins, there are too few stacks to fit both size-only and size+activation models reliably.
  + The AIC comparison becomes statistically unstable or not identifiable.

When T3-B is run anyway under the strict gates:

* KiDS does **not** yield a stable, quantitative detection of MW activation:
  + It neither shows a strong positive (\Delta\mathrm{AIC}\_\Sigma) nor a robust negative one.
  + The correct summary is that it is **coverage-limited** for this test.

However:

* The **underlying T3 pattern** (low-bin lacking the mid/high positive size effect) is still there.
* The size–plateau behaviour is **qualitatively consistent** with the DR5 story:
  + Low bin: no clear positive activation.
  + Mid/high: positive trends, within the limits of what can be measured.

So for T3-B:

* **KiDS is neutral**:
  + It does not independently confirm the MW activation model.
  + It also does not contradict the DR5 result or the AR container picture.

**6.4.4 How DR5 informs KiDS**

Given that:

* DR5 provides a strong MW-activation detection with a plausible (R\_{\text{MW}}) (~6 kpc).
* KiDS shows the **same qualitative mass-bin pattern** as DR5 but lacks stacks for a full T3-B comparison.

It is reasonable to:

* Treat DR5 as the **primary dataset** for the MW activation detection.
* Treat KiDS as **pattern-consistent** but statistically weaker:
  + It suggests the same underlying mechanism is at work.
  + It simply doesn’t have the leverage to re-derive the MW scale on its own under strict gates.

We do **not** claim an independent MW-scale measurement from KiDS. Instead, we note that its pattern fits naturally into the same container-based explanation that DR5 supports.

**6.5 T3/T3-B synthesis**

T3 and T3-B together give a coherent picture of galaxy–galaxy lensing plateaus in the AR/container framework.

**6.5.1 Final view of low, mid, and high mass bins**

Putting everything together:

* **Low mass bin**:
  + T3: no strong positive size slope; behaviour close to baseline.
  + AR interpretation: galaxies here are mostly **sub-MW size**, so the +3 container is effectively **inactive**.
  + T3-B (DR5): low bin does not drive activation; its stacks can participate in the model but don’t show extra activation on their own.
  + Conclusion: **full AR pass as a non-activated regime**.
* **Mid mass bin**:
  + T3: clear positive size trend; larger galaxies have higher (A\_\theta).
  + AR: this is where many galaxies first **cross the MW threshold**; +3 container turns on.
  + T3-B: activation fraction explains additional variance in (A\_\theta) beyond size-only; strong contribution to the positive activation slope.
* **High mass bin**:
  + T3: positive size trend, similar in magnitude to mid bin.
  + AR: galaxies here are **fully in +3** and beginning to feel +4-scale effects; the container is strongly active.
  + T3-B: high bin contributes significantly to the overall (\Delta\mathrm{AIC}\_\Sigma).

All three bins thus line up with a **single AR story** once MW activation is included:

* Below MW scale → no activation → baseline behaviour (low bin).
* Around/above MW scale → activation → positive size–plateau trends (mid/high).

**6.5.2 Combined evidence vs GR expectations**

From the combined T3/T3-B perspective:

* Data show:
  + Positive size slopes in mid/high bins.
  + No positive activation in low bin.
  + A preferred Milky-Way size scale (~6 kpc) in DR5, with a large AIC improvement for the activation model.
  + The same underlying mass-bin pattern in KiDS, though with weaker statistics.
* AR explains this via:
  + A container hierarchy in which:
    - The Milky Way acts as a +3 container.
    - An extra feasibility gradient around galaxies (and thus an extra lensing contribution) **activates** when galaxies reach that scale.
  + A simple MW-anchored activation variable ((f\_{\text{MW}})) that improves our ability to describe (A\_\theta).
* GR, in a naive size-only picture:
  + Would generally expect **negative or null** size trends at fixed mass.
  + Has no natural built-in **Milky Way–specific** activation threshold.

Thus, T3/T3-B provide:

* A pattern of behaviour that:
  + Fits directly into the AR container view (especially the UGM → Earth → MW ladder).
  + Is nontrivial to reconcile with plain GR without adding extra, tuned structure.

**6.5.3 Status and next steps**

**Status**

* T3:
  + **PASS**: finds robust positive size–plateau trends in mid/high bins and a non-activated low bin, consistent across two datasets.
* T3-B:
  + **DR5**: **strong PASS** for a Milky-Way–anchored activation model; preferred (R\_{\text{MW}}) ~ 6 kpc; large (\Delta\mathrm{AIC}\_\Sigma); positive activation slope.
  + **KiDS**: **neutral but consistent**; coverage-limited but shares the same low vs mid/high pattern.

Taken together, T3 + T3-B **jointly pass** the AR Milky Way activation prediction.

**Next steps**

* Apply the same MW-anchored activation analysis to:
  + Additional surveys and stacking schemes.
  + Possibly looser or alternative plateau gates (as secondary checks).
* Tie the T3/T3-B results more tightly into:
  + The full hinge-scale amplitude chain (UGM, Earth-ring, χ).
  + The broader container ladder (clusters and larger-scale structures as +4, etc.).
* Explore explicit comparisons with specific GR-based lens models under the same T3/T3-B gates, to make the contrast even more concrete.

This completes the record of the T3/T3-B lensing simulations at the V2/V2.1 level and sets the stage for future, more compact summaries and analyses built on top of these results.

**6.6 Planned T3/T3-B verification and GR comparison**

The T3 and T3-B results in this attachment are already strong in three ways:

* They are obtained with a **fixed engine-linked pipeline** (plateau gates, amplitude chain, no halo fitting).
* They show a **structured pattern** — “low mass off, mid/high mass on” — rather than just “somewhere the slope is positive.”
* They tie cleanly into the existing **container ladder** via a Milky-Way–scale activation picture.

However, they are **not yet** a fully closed test against GR+ΛCDM. In particular, standard GR+ΛCDM could, in principle, generate positive size–lensing correlations at fixed stellar mass via correlated halo mass, concentration, and environment. To move from “AR-consistent and suggestive” to “sharp test against GR+ΛCDM,” several additional steps are planned.

**6.6.1 GR+ΛCDM mock catalogues through the T3/T3-B pipeline**

The first priority is to run **realistic GR+ΛCDM mocks** through the **exact same T3/T3-B pipeline**:

* Build or obtain mock galaxy catalogues with:
  + Stellar mass , effective radius , halo mass, concentration, and environment, consistent with GR+ΛCDM.
* Generate mock galaxy–galaxy lensing profiles for these catalogues (either from simulation shear maps or analytic NFW-style lensing).
* Apply the **unchanged** T3/T3-B pipeline:
  + Same mass/size bins.
  + Same plateau band and flatness gates.
  + Same amplitude chain and Aθ estimator.
  + Same size-only vs size+activation fits and AIC comparisons.

Key questions:

* Do GR+ΛCDM mocks reproduce:
  + The **positive size slopes** in mid/high mass bins, *and*
  + The **“low-bin off / mid–high on”** pattern?
* Does a Milky-Way–anchored activation term provide a significant AIC improvement in mocks, or is a size-only model sufficient?

If **realistic GR+ΛCDM mocks cannot reproduce** the observed pattern under this fixed pipeline, that will strongly support the claim that T3/T3-B expose behaviour that is difficult for GR to explain. If they *can* reproduce it, the result still has value: T3/T3-B would then be a **consistency check** with AR, but not yet a discriminator against GR.

**6.6.2 Robustness tests within the T3/T3-B pipeline**

In parallel, several internal robustness checks are planned:

* **Bin and gate variations**
  + Shift stellar-mass and size bin edges within reasonable ranges.
  + Loosen/tighten plateau flatness gates and try slightly different plateau bands.
  + Check that the basic **“low off / mid–high positive”** pattern survives.
* **Alternative plateau definitions**
  + Test modest variations of the plateau statistic (e.g. slightly different θ-ranges or weighting schemes) to ensure the effect is not tied to one narrow choice.
* **Jackknife / bootstrap diagnostics**
  + Jackknife over sky regions to check that no single region dominates the signal.
  + Bootstrap galaxies within bins to refine uncertainties on size slopes and activation coefficients.

These tests are aimed at showing that the T3/T3-B pattern is **stable under reasonable analysis choices**, not a fragile artefact of one very specific configuration.

**6.6.3 Cross-survey replication with a fixed ladder and activation scale**

Once the T3/T3-B pipeline and the Milky-Way activation picture are settled:

* **Freeze** the container ladder choices and the preferred Milky-Way activation radius (as inferred from DR5 and the broader hinge-scale calibration).
* Apply the **unchanged** T3/T3-B pipeline to at least one **independent survey** (e.g. an HSC or future LSST lensing dataset) with analogous mass and size information.

The key questions here:

* Does the same **low/mid/high pattern** reappear?
* Does a size+activation model again outperform size-only with a similar MW-scale activation band?

A successful replication under a **fixed theory and pipeline** would upgrade the current T3/T3-B story from a post-hoc explanation to a **genuinely predictive test**.

**6.6.4 Differential tests: redshift, environment, and morphology**

Further discriminating tests are planned along the following lines:

* **Redshift evolution**
  + Split lens samples into redshift bins and test whether activation strength or preferred scale evolves in a way consistent with the container ladder story.
* **Environment and morphology**
  + Compare centrals vs satellites, cluster vs field, and early-type vs late-type galaxies.
  + AR suggests that the **container scale** is primary, whereas GR+ΛCDM may naturally tie the effect more directly to environment or morphology.

These differential tests can help distinguish between **purely halo-driven** explanations and deeper geometric/container-level effects.

**7. Global Status & Relation to V1**

This section pulls together the **overall status** of the V2/V2.1 simulation programme and explains how it fits with the earlier V1-era simulations recorded in Part I.

At a high level:

* All of the core V2 engine and Matter-Addition families have **passed** their intended tests.
* The UGM → gravity triad shows that a **single amplitude chain** can account for deflection, delay, and redshift at hinge scales.
* The external-data suites (T1–T3-B) have:
  + Delivered **clear positive results** where the data permit (T2, DR5 T3/T3-B).
  + Identified some **pending** or **neutral** cases where data or calibration are not yet sufficient (T1 amplitude mapping, KiDS T3-B).

The subsections below record this more systematically and then connect it back to the V1 story.

**7.1 Status summary table**

This subsection summarises the status of each major V2/V2.1 simulation family. It is written as a textual “table” for easy reading and later reference.

**Core engine simulations (Section 2)**

* **Locality, budgets, PF/Born ties-only**
  + *Purpose:* Verify engine contract (no-skip, SR budgets, ties-only randomness, no-signalling).
  + *Status:* **PASS** — all checks behave as intended; no violations found.
* **Q-series (Q1–Q5)**
  + *Purpose:* Show gravity-like, interferometric, CHSH, and complementarity behaviour from feasibility geometry.
  + *Status:* **PASS** — structural phase, JFM focusing, horizon-like behaviour, CHSH trend, and complementarity all appear with correct qualitative patterns and hygiene intact.
* **Decoherence & hygiene baselines**
  + *Purpose:* Provide reference interference/decoherence scenes and check diagnostics integrity.
  + *Status:* **PASS** — expected V/D trends and clean replay/hygiene behaviour.

**Matter-Addition suite A1–J28 (Section 3)**

* **A1–A3 (SR baseline, isotropy, monotone strictness)**
  + *Status:* **PASS** — SR structure unaffected by schedule; isotropy and monotone strictness confirmed.
* **A4–B6 (measure invariance & Earth-ring anchor)**
  + *Status:* **PASS** — single-read discipline holds; Earth-ring provides a stable amplitude calibration.
* **D9–D12 (counts-only EM analogues)**
  + *Status:* **PASS** — Gauss-like plateau, 1/r tail, E/B phase & polarization recovered from counts.
* **E13–E15 (redshift, delay, deflection)**
  + *Status:* **PASS** — gravity-style optical behaviour from feasibility geometry with mesh audits.
* **F16–F17 (horizons & interference)**
  + *Status:* **PASS** — horizon reachability and two-source interference behave as designed.
* **G18–G20 (mesh, boundary, re-centring)**
  + *Status:* **PASS** — curves are stable under mesh changes, re-centring, and boundary masks.
* **H21–H23 (spectroscopy & structure)**
  + *Status:* **PASS**, with note: early H21 config/diagnostics issue was found and fixed; final runs show the intended plateau/rim and line/cohesion behaviour.
* **I24–I26 (no-signalling, tie-kernel, diagnostics integrity)**
  + *Status:* **PASS** — no-signalling at machine precision; tie RNG behaves correctly; diagnostics do not alter control.
* **J27–J28 (SI overlays)**
  + *Status:* **PASS** — SI labelling is confirmed to be pure post-processing.

**UGM → gravity triad (Section 4)**

* **Deflection, Shapiro-like delay, redshift**
  + *Purpose:* Test whether a single amplitude family (UGM + Earth-ring + χ) can fit all three hinge-scale observables.
  + *Status:* **PASS** — all three panels fall within the preregistered band; mesh and recenter audits pass.

**External rotation & RAR (Section 5)**

* **T1 – Rotation-plateau machinery**
  + *Purpose:* Build and audit the rotation-plateau (v\_flat) finder.
  + *Status:*
    - **Methodology:** **PASS** — plateau windows and v\_flat values are stable and robust.
    - **Amplitude mapping to full hinge chain:** **PENDING** — current AR amplitude is a placeholder and not treated as a final claim.
* **T2 – RAR with AR scaling**
  + *Purpose:* Examine SPARC’s RAR behaviour in light of AR expectations (slope ~1/2, single g\* scale).
  + *Status:* **PASS** on core behaviour — low-g slope near 1/2 and single-scale collapse;
    - *Pending refinement:* tie g\* more directly to the full hinge-scale chain (UGM, Earth-ring, etc.).

**Galaxy–galaxy lensing plateaus (Section 6)**

* **T3 – Size–plateau trends (KiDS & DR5)**
  + *Purpose:* Measure how plateau amplitude (A\_\theta) depends on galaxy size at fixed mass.
  + *Status:* **PASS** — mid/high mass bins show robust positive size trends; low mass behaves as a non-activated regime, consistent with AR once T3-B is considered.
* **T3-B – MW-anchored activation (KiDS & DR5)**
  + *DR5 branch:*
    - *Purpose:* Test MW-anchored activation model via activation fraction (f\_{\text{MW}}).
    - *Status:* **PASS** — strong AIC preference for activation model; preferred (R\_{\text{MW}}) ~ few kpc; positive activation slope.
  + *KiDS branch:*
    - *Purpose:* Same model under same gates.
    - *Status:* **NEUTRAL / COVERAGE-LIMITED** — too few claimable stacks to resolve the model; pattern is consistent with DR5 but not an independent confirmation.

In summary, there are:

* No genuine **V2-era obstructions** analogous to the V1 naive kernel→metric failure.
* A small number of **pending/neutral** items (T1 amplitude mapping, hinge-tied g\*, KiDS T3-B) that are explicitly labelled as such and do not contradict the main AR picture.

**7.2 How V2 completes and extends the V1 story**

Part I (V1 sims) and Part II (V2 sims) fit together as two halves of the same programme:

1. **V1 sims (Part I)**
   * Worked directly with:
     + The abstract operator algebra (F, S, T, C, CT, etc.).
     + Tick chains and kernels (Vol.3).
     + Standalone gauge modules and FPHS (Vol.4).
     + Early gravity/measurement tests, including:
       - A known obstruction (naive kernel→metric Sim 2).
       - A successful compact-curvature translator (Sim 2b).
       - Designed pointer sims (Sim 3a/3b), only partially run (f=0).
   * Their role was to show that the **formal theory is self-consistent** and that the compact-curvature construction works in its own natural language.
2. **Bridge document**
   * Took these V1 objects and mapped them into the V2 engine:
     + Ladder bands → engine bands and manifest config.
     + Kernels and pivots → ParentGate strictness profiles and schedules.
     + Operator algebra → engine transitions, budgets, and SR identity.
   * Defined what it means for the engine to be a **faithful implementation** of the theory.
3. **V2 sims (Part II)**
   * Tested that mapping in practice and extended it to real data:
     + **Core engine sims (Section 2)** validate the engine contract:
       - Locality, SR budgets, ties-only randomness, and hygiene.
       - Interference, decoherence, CHSH, complementarity, and gravity-style behaviour from feasibility geometry alone.
     + **Matter-Addition suite (Section 3)** realises V1-like gauge/geometry structure with a single matter schedule:
       - Counts-only EM analogues; geometry under gravity; horizons; spectroscopy-like patterns.
       - Strong mesh and re-centring checks tie these panels back to the V1 intuition that gauge/geometry structure can emerge from discrete flips and kernels.
     + **UGM → gravity triad (Section 4)** is the engine-level successor to V1’s compact-curvature success (Sim 2b):
       - Deflection, delay, and redshift all match under one hinge-scale amplitude chain, now implemented as ParentGate schedules rather than metric fields.
     + **External-data suites (Sections 5–6)** extend the story beyond toy universes:
       - T1/T2 show that rotation curves and RAR can be brought into the same pattern (low-g slope ~1/2, single g\*).
       - T3/T3-B show that galaxy–galaxy lensing plateaus display a Milky-Way–anchored activation pattern consistent with AR’s container hierarchy and tension with naive GR size expectations.

Viewed together:

* V1 + Bridge + V2 form a continuous chain from:
  + **Abstract AR framework**, through
  + **Engine implementation of that framework**, to
  + **Simulated and observed phenomena** at multiple scales (from hinge-scale deflection to galaxy rotation and lensing).

The V2 results do not replace the V1 ones; they **complete and extend** them by:

* Showing that the same underlying structure can run as a present-act engine with strict rules.
* Demonstrating that this engine, when driven by a matter schedule consistent with AR, produces patterns that can be connected to real data without introducing hidden tunings in control.

**7.3 Open questions & future simulation directions**

The simulations in Part II establish a strong base for the V2/V2.1 engine and its connection to data, but they also suggest several natural next steps.

**1. Pointer classicalization vs measurement fraction (f)**

* The original V1 pointer simulations (Sim 3a/3b) only ran the **f = 0** baseline.
* At the engine level, there is a clear path to:
  + Implement pointer-like subsystems inside (W\_k).
  + Embed compact-source potentials via ParentGate patterns.
  + Sweep measurement fraction (f) via MICC-style gates.
* Future sims can:
  + Measure Corr(f) between engine pointer paths and classical reference paths.
  + Track path deviation and interference suppression vs f.
  + Complete the pointer classicalization story in the V2 framework.

**2. Larger-scale gauge/ladder engine tests**

* A1–J28 focus mainly on hinge-scale EM analogues and small structures.
* Possible extensions include:
  + Richer ladder experiments that more directly emulate V1’s full SU(N) lattice constructions.
  + Multi-band scenarios where transitions between (−2, −1, 0, +1, +2, +3) are explicitly explored in one coherent engine world.
  + Tests of renormalisation-like flows, where moving up/down the ladder corresponds to coarse-graining/refinement in the engine.

**3. Direct hinge-tied calibration for T1/T2**

* T1 and T2 already show promising alignment with AR expectations:
  + Robust plateau machinery (T1).
  + Low-g slope ~1/2 and single g\* for the RAR (T2).
* A clear next step is to:
  + Tie the rotation/RAR scale g\* much more directly into the UGM → Earth → MW chain.
  + Use the same χ and amplitude inputs that underlie the UGM triad and the T3/T3-B lensing analyses.

**4. Further galaxy–lensing and container-level tests**

* T3/T3-B have identified a Milky-Way-like activation scale in DR5 and a consistent pattern in KiDS.
* Extensions could include:
  + Applying the same MW-anchored activation analysis to additional surveys.
  + Testing other container levels (+4, e.g. cluster scales) using stacked cluster lensing or large-scale shear data.
  + Investigating whether similar activation behaviour appears at scales associated with larger containers.

**5. Additional external datasets and cross-checks**

* Beyond rotation and galaxy–galaxy lensing, other potential tests include:
  + Strong-lensing time delays.
  + Cluster mass profiles and weak lensing.
  + CMB lensing and integrated Sachs–Wolfe-type signals.
* The same engine/feasibility geometry logic, combined with careful selection and flatness/mesh-style diagnostics, can be used to design new T-series simulations aimed at these regimes.

In all cases, the guiding principle remains:

* Keep the **engine contract** and the **Bridge mapping** fixed.
* Add only the necessary schedules and diagnostics to probe new regimes.
* Maintain clear audits (mesh, flatness, re-centring, no-signalling) so that each new block of simulations can be slotted into the same overall structure recorded in this attachment.

**8. Code & Reproducibility Notes**

This section records how the simulations described in this attachment are implemented in practice, how the code is organised, and what would be required for someone (including your future self) to rerun or extend them.

The main points are:

* All implementations live in **private repositories**, which you control.
* The **engine contract** and **Bridge mapping** are assumed fixed.
* This document is the **human-readable record** of what each simulation family does and how it fits into the overall picture.

**8.1 Private repositories and request policy**

All simulations in this attachment were run using internal codebases rather than public GitHub repositories. Concretely:

* The **present-act engine** (V2/V2.1), including:
  + Site/record structures,
  + Gate implementations (Θ, κ, MICC, ParentGate, etc.),
  + Budget handling and SR identity enforcement,
  + Ratio-lex acceptance and PF/Born ties-only logic,  
    lives in one or more core engine repos.
* The **Matter-Addition suite (A1–J28)**:
  + Schedules and strictness profiles,
  + Panel definitions (D9, E15, H21, etc.),
  + Mesh and re-centring scaffolding,  
    are implemented as configuration and driver layers on top of the engine.
* The **UGM → gravity triad** and **external-data suites (T1–T3-B)**:
  + Use specialised analysis scripts,
  + Workflows for reading catalogue data (SPARC, KiDS, DR5),
  + Window/plateau finders, fitting routines, and AIC/diagnostic calculation.

These repos are:

* **Private** by default.
* Treatable as the **canonical implementation** of the simulations described here.
* **Shareable on request**:
  + Code, manifests, and configuration files can be provided to collaborators or reviewers if needed, under whatever access model you choose at the time.

This attachment does not attempt to mirror the exact file structure or all script names. Instead, it gives a **simulation-level view**: for each simulation family, it records the purpose, the engine features used, and the key steps, so you can always map back to the corresponding code later.

**8.2 What is required to reproduce the results**

Although the code is private, the simulations are intended to be reproducible in principle. A technically competent reader (or your future self) would need the following ingredients.

**8.2.1 For engine-level simulations (Sections 2–4)**

1. **Engine specification**
   * Definition of sites (k), world and qualia records (W\_k, Q\_k).
   * Feature alphabet(s) and hinge equality rules.
   * Full semantics of:
     + Θ and κ gates,
     + MICC/measurement gates,
     + ParentGate (including how strictness schedules map to feasibility).
   * Ratio-lex acceptance algorithm and how PF/Born is applied to ties only.
   * Typed budgets ((\Delta \tau, \Delta t, \Delta x)) and SR identity enforcement.
2. **Manifest format and schedule encoding**
   * How to describe a simulation world in a manifest:
     + Grid/graph layout,
     + Active bands or context levels,
     + Strictness schedules (radial, ladders, horizons, etc.),
     + Run lengths, sampling schemes, mesh variants.
   * Audit options:
     + Mesh pair definitions,
     + Re-centring offsets,
     + Boundary-mask toggles,
     + Diagnostic logging levels.
3. **Per-panel configuration**
   * The specific manifest blocks corresponding to each A1–J28 panel, the UGM triad runs, and the Q-series scenes:
     + Source regions and detector arrangements,
     + Impact-parameter grids, radial shells, sector partitions,
     + Any measurement fraction (f) values, where relevant.

With these in hand, plus the engine code, all A1–J28, UGM, and Q-series simulations can be re-run and checked against the curves and patterns described in Sections 2–4.

**8.2.2 For external-data simulations (Sections 5–6)**

1. **Catalogue access**
   * SPARC rotation-curve catalogue for T1/T2.
   * KiDS and DR5 lensing stacks (or the underlying data plus stacking scripts) for T3/T3-B.
2. **Selections and binning rules**
   * Galaxy quality cuts (inclination, data coverage, etc.) for SPARC.
   * Stellar mass and size bin definitions for lens samples (low/mid/high mass; size bins).
   * Redshift ranges and quality flags for lensing sources.
3. **Processing pipelines**
   * For T1 (rotation plateaus):
     + Window and flatness criteria (slope and scatter thresholds).
     + How v\_flat is defined and averaged, and how resampling/“mesh-like” checks are done.
   * For T2 (RAR):
     + Formulas for (g\_{\text{bar}}) and (g\_{\text{obs}}).
     + Low-g selection for RAR fits.
     + How the single scale (g\_\*) is fit and how residuals are assessed.
   * For T3 (plateaus):
     + Definition of ΔΣ or (\gamma\_t(\theta)), random subtraction, and the θ-range used.
     + Plateau/flat-window gates and confidence interval computations.
     + Rules for marking stacks as “claimable”.
   * For T3-B (MW activation):
     + Definition of MW-relative size (x = R\_G / R\_{\text{MW}}).
     + How activation fraction (f\_{\text{MW}}) is computed per stack.
     + Linear models for (A\_\theta) vs size and vs activation fraction.
     + AIC calculation and scanning of (R\_{\text{MW}}) (and any mild mass exponents).

With those steps reproduced, and the same plateau/flatness gates and AIC conventions, an independent implementation should recover:

* Similar low-g RAR slopes and single-scale collapse in T2.
* Similar size–plateau trends in T3.
* A similar MW-scale activation detection in DR5 and the same “neutral but consistent” pattern in KiDS.

**8.3 Role of this attachment in your workflow**

This attachment is meant to play three roles in your broader workflow:

1. **Canonical V2/V2.1 simulation log**
   * It is the **single, coherent record** of:
     + Which simulation families exist at the engine level,
     + How they were set up,
     + What they showed,
     + What their current status is (Pass / Pending / Neutral).
   * It can be timestamped on the blockchain as a reference snapshot of the state of the V2 simulation programme at this stage.
2. **Reference for future summaries and publications**
   * When you later write:
     + More compressed technical notes,
     + Articles, talks, or defensive publications,  
       you can extract the specific pieces you need (e.g. T3-B summary, UGM triad summary) from here.
   * The detailed structure recorded here ensures that:
     + You know what assumptions were made where.
     + You can track how interpretive shifts (e.g. the T3 low-mass bin) arose from new simulations (T3-B).
3. **Guide for future simulation extensions**
   * The way the existing families are documented—purpose, setup, diagnostics, status—provides a template for:
     + New pointer-classicalization runs,
     + Extended gauge/ladder experiments,
     + Additional external-data suites at other scales.
   * New simulation families can be slotted into the same structure (Sections 2–6 with status reflected in Section 7), keeping the overall programme coherent and easy to navigate over time.

In short, this attachment is **your own simulation ledger** for the V2/V2.1 era: a durable record of how the present-act engine has been tested so far, what it has passed, where some pieces are still pending or neutral, and how all of that ties back into the larger Absolute Relativity framework.