# Substrate Cosmology Volume Six

## Recurrence Research and the Labyrinth

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# Publication and Copyright Notice



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**Author and research originator:** James Dunn
**Editorial, analytical, and production collaboration:** OpenAI ChatGPT (Codex)
**Earlier AI-assisted source development:** Microsoft Copilot and Google Gemini
**Public research commons:** https://substrate-cosmology.james-dunn866549.chatgpt.site

This book presents a developing research program. Substrate Cosmology and Fibered Relational Tensor Theory are not established physical theories. The recurrence results documented here establish organization in a particular information and measurement system under specified constructions. They do not establish unknown physics, String Theory, nonlocality, consciousness effects, causal influence, or substrate ontology.

The current recurrence experiment uses GDELT 1995 as open development data. Its inherited blind-validation boundary leaves 1996 and later years unopened. Cryptocurrency, stock, commodity, financial, and other outcome layers remain unopened for this experiment. This volume describes the boundary and the frozen candidates; it does not authorize opening, scoring, or interpreting held-out data.

# Authorship and AI Collaboration

James Dunn originated Substrate Cosmology, the distinction between Actual Physics and represented physics, the treatment of recurrence as more general than vibration, the Labyrinth principle, the Relational Tools, the Recovery Point system, and the requirement that operationally useful relations remain separate from claims about what fundamentally exists. He supplied the research corpus, corrections, archives, intent records, and public website from which this volume was developed. He retains responsibility for the claims and publication.

OpenAI ChatGPT (Codex) reviewed the available Library project and website, verified the RP07 parent and its permitted boundary, reconstructed the conceptual and operational dependencies, separated recurrence from recursion and periodicity, organized the null-world and frame-shaking programs, drafted and edited the text, prepared the tables and appendices, produced the document, and integrated this volume with the public research commons.

Microsoft Copilot and Google Gemini are acknowledged for earlier assistance recorded in the source manuscripts. AI systems are cited as collaborators in representation, analysis, and production. They are not empirical witnesses, independent replicators, scientific authorities, or evidence that any physical claim is true.

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# Contents

# Preface

The first five volumes prepared the conceptual and experimental boundary for this book. Volume One separated Actual Physics from any observer's representation. Volume Two examined the losses introduced by words, numbers, units, and equations. Volume Three organized the Relational Tools. Volume Four developed a mathematical program for regime-indexed representations and recovery maps. Volume Five treated apparatus and detectors as physical participants in measurement.

Volume Six asks how a relation can return without first being reduced to a repeated number, a periodic waveform, or a familiar object. The question sounds simple until ordinary vocabulary begins deciding the answer. A repeated value is easy to count. A repeated shape is easy to plot. A repeated period is easy to call frequency. Yet relational organization may recur when values, participants, intervals, paths, and surface descriptions change.

The project therefore begins with recurrence rather than vibration. Vibration is permitted as one temporal and spatial specialization. It is not permitted to define recurrence in advance. Recursion is also kept separate: a process can use its own output without returning to a prior relational organization, and a relational organization can recur without being generated recursively.

The Labyrinth is the operational response to this difficulty. It preserves many provisional scalars, residuals, encodings, adjacency systems, operators, missingness patterns, failed transformations, and unhelpful fragments. Most will remain useless. That is expected. Premature deletion would allow today's interpretive frame to decide which relations tomorrow's frame is allowed to reveal.

Preservation alone is not discovery. The same abundance that protects weak signals creates enormous selection freedom. The Labyrinth therefore requires neutral identifiers, graduated null worlds, candidate freezing, blind validation, multiplicity control, complete frame ensembles, and explicit failure records. The project's skepticism must grow with its expressive power.

This volume uses the actual RP0 through RP07 recurrence program as a worked case. GDELT 1995 is development data. The first held-out year, 1996, remains unopened. The book reports the retained 1995 findings and their ordinary explanations, but it does not treat them as blind confirmation. It also reports the project's operational failures, including unsafe extraction, non-immutable freezing, invalid-candidate acceptance, false logging after failed state mutation, and an unresolved feature definition. Later hardening does not rewrite those failures into historical successes.

## The Current Series

The series has no predetermined length. Volumes may divide, combine, or change order when conceptual dependencies, formal results, or evidence require it.

| Volume | Working title | Primary task |
|---|---|---|
| One | Introduction to Substrate Cosmology | Establish the alternate perspective and research boundaries. |

| Volume | Working title | Primary task |
|---|---|---|
| Two | Words Units and the Collapse of Physical Representation | Make linguistic numerical metrological and mathematical selection inspectable. |
| Three | The Relational Tools and Their Developmental Lineages | Preserve explain crosswalk and operationalize the Tool architecture. |
| Four | Relational Mathematics and Fibered Relational Tensor Theory | Develop formal objects projections recovery maps and conservative extension. |
| Five | Measurement Detectors and Experimental Interaction | Model apparatus controls independent projections and discriminating interventions. |
| Six | Recurrence Research and the Labyrinth | Develop recurrence methods blind archives null worlds and prospective validation. |
| Seven | Cosmology Matter and Emergent Physical Quantities | Reconsider spacetime matter fields gravity energy entropy horizons and dark phenomena. |
| Eight | Conditional Engineering and Physical Manipulation | Examine intervention and engineering only under explicit evidence and safety gates. |
| Nine | Intelligence Agency Identity and Dimensional Stewardship | Develop relational learning culture ethics AI and propagation of diverse life. |
| Ten | Substrate Cosmology Website User Manual | Document the research commons investigation routes evidence boundaries and continuity controls. |

Volume Seven will use the representational, mathematical, experimental, and recurrence disciplines established here before reconsidering cosmological quantities. Volume Ten remains the dedicated website manual. Chapter Sixty supplies only the recurrence-research user’s guide needed to navigate the present evidence.

# Acknowledgments

This volume grows from James Dunn's insistence that recurrence should not be forced back into vibration and that seemingly useless fragments should remain available long enough to reveal relations across alternative frames. His corrections also established that recursion, synergy, sympathy, resonance, and dimensional bleed are related possibilities, not synonyms.

OpenAI ChatGPT (Codex) is acknowledged for Library audit, dependency reconstruction, conceptual criticism, evidence-status separation, manuscript development, document production, and website integration. Microsoft Copilot and Google Gemini are acknowledged for earlier recorded assistance. Their work is provenance, not confirmation.

The recurrence methodology also draws on established recurrence analysis, nonlinear time-series methods, surrogate-data testing, graph and network comparison, reproducible computation, and open-science practice. Those fields do not endorse Substrate Cosmology. Their methods constrain it.

# Reader Guide

## Status Labels

| Label | Meaning |
|---|---|
| Preserved evidence | Retained source data code output log or historical statement. |
| Reconstructed behavior | New implementation that reproduces retained behavior without claiming recovered source. |
| Project definition | A stipulated term used to organize this research. |
| Exploratory result | A relation found within development data and exposed to adaptive choice. |
| Frozen candidate | A definition commitment fixed before its declared held-out test. |
| Blind result | A result produced without opening or using the held-out outcome during candidate formation. |
| Operational usefulness | Predictive or discriminating value under declared conditions without an ontological claim. |
| Physical claim | A claim requiring independent apparatus evidence and recovery of established physics. |

## Four Questions for Every Recurrence Claim

1. What is permitted to vary while the recurrence is called the same?
2. Under which representation adjacency and tolerance does it recur?
3. Which null worlds and ordinary mechanisms were excluded?
4. Was the rule fixed before the data used to judge it were opened?

## Reading Paths

Researchers new to the project should read the Introduction and Parts I through III in order. Data scientists may begin with Parts III and IV, then return to the conceptual distinctions in Part I. Researchers designing alternate frames should read Parts II and V together. Archivists and continuity stewards should begin with Part VI. Experimental physicists can move from Parts I, IV, and V to Part VII and then return to Volume Five.

# Introduction

## Recurrence Before Meaning

Suppose two observations look different under every familiar label, yet a transformation among their relations is preserved. Has something recurred? The answer depends on what is allowed to count as identity. If identity means equal scalar values, perhaps not. If it means equivalent connectivity, conditional susceptibility, ordering, or transformation structure, perhaps yes.

Substrate Cosmology uses recurrence as a provisional way to search for return or preservation of relational organization. A general record is

$$R=(X, F, D, A, T, \epsilon, N, P),$$

where $X$ is the carrier, $F$ the frame, $D$ the declared dimensions, $A$ the adjacency relation, $T$ the transformation or comparison, $\epsilon$ the tolerance, $N$ the null family, and $P$ the provenance. No component is universal. Changing one can reveal, dissolve, split, or manufacture apparent recurrence.

Conventional recurrence plots begin from repeated neighborhood visits in a reconstructed state space. They are valuable established tools. This program broadens the question beyond one temporal indexing and one metric space. Chronology remains essential provenance and can be one adjacency, but actor relation, category, geography, network neighborhood, configuration, shared boundary, and operator-defined accessibility may provide others.

The broadening creates risk. With enough representations, a pattern can almost always be found. The correct answer is not to ban alternative frames. It is to register the search, preserve the whole attempted ensemble, estimate selection burden, calibrate with synthetic signals, freeze candidates, and use blind data.

## The 1995 Experiment in One Page

The original development archive contains 1,780,524 coded GDELT observations from 1995 with 57 retained fields. Two principal segmentations were constructed: 365 calendar-day groups and 357 sequential equal-event groups, including one incomplete 524-event group. Frozen scoring excludes the incomplete group, leaving 356 complete 5,000-event groups.

The project constructed sixteen neutral scalarizations and six recurrence descriptors. It retained four cross-resolution recurrence-mode families and four auxiliary candidates. Sequential adjacency and mutual-nearest structure differed strongly from preliminary destructive nulls, and event-root self-transitions showed large lifts. These results establish structured organization in the GDELT information system under the chosen construction. They may reflect persistence, source batching, coding practices, institutional processes, ordering, aggregation, or domain-local dynamics.

The eight candidates were frozen under the RP02 commitment

$$0fb46e1d7843b613ef1662ecba04333e7e83ca266589ff7ccbd036ce721fccb8.$$

That commitment is identity evidence, not scientific validation. Its purpose is to prevent later choices from silently changing what will be tested.

## What This Volume Does Not Do

This volume does not open 1996, score the frozen candidates on later data, inspect market outcomes, or interpret the neutral families as physical modes. It does not claim that information-system recurrence reveals a precausal substrate. It explains how those questions can be asked without allowing the answer to be built into the representation.

# Part I

## Recurrence Before Meaning

# Chapter One

## What Recurrence Means Here

Recurrence is the reappearance or preservation of a characterized relation under a declared representation and tolerance. The definition is intentionally indexed. A state return, a graph motif, a transition, a split-join transformation, or a susceptibility profile can recur even when their surface values differ.

Let $O_{F,D}$ be an observation map within frame $F$ and dimension set $D$. A simple recurrence indicator is

$$R_{F,D,A,\epsilon}(i,j)=1\left[d_{F,D,A}\left(O(x_i),O(x_j)\right)\leq\epsilon\right].$$

This is a construction, not a definition of Actual Physics. The metric, adjacency, observation map, and tolerance decide which differences disappear. A more general operator may compare relational structures rather than points:

$$R(i,j)=1\left[\Delta(G_i,G_j;T)\leq\epsilon\right].$$

The experimental record must say what $G$, $T$, $\Delta$, and $\epsilon$ mean and what null distribution makes the comparison informative.

# Chapter Two

## Recurrence and Repetition

Exact repetition is one limiting case of recurrence. A copied bit string repeats. A periodic signal repeats values after a fixed interval. Relational recurrence permits component substitution, changed magnitude, irregular separation, and transformed appearance when a declared invariant remains.

This latitude cannot be retrospective. If a researcher changes the invariant after seeing each new case, every outcome can become a recurrence. Identity conditions therefore belong in the candidate freeze. The tolerance must be calibrated against measurement, expected variability, and false matches.

The project distinguishes surface recurrence from structural recurrence. Surface recurrence retains familiar values or labels. Structural recurrence retains connectivity, ordering, transition, compatibility, or response. Neither is inherently deeper. Their value depends on prospective discrimination.

# Chapter Three

## Recurrence and Recursion

Recursion is repeated self-application: a process uses a prior output, state, or rule in later production. Recurrence is return or preservation of organization. A recursion can move continually into new configurations without returning. A recurrence can arise from cycles, common constraints, external forcing, replacement of components, or chance without recursive generation.

The distinction matters because the developmental Tools themselves form a recursion. Each representation produces findings and failures that influence the next representation. That process may reveal recurrence, but its own repeated revisions are not evidence that the studied system contains the same mechanism.

When relations among recurrences become new data, recursive construction is allowed. Each level must retain its input lineage and must be tested independently. Higher order does not mean more fundamental.

# Chapter Four

## Recurrence and Vibration

Vibration ordinarily presupposes a coordinate displacement, equilibrium, time parameter, amplitude, frequency, phase, and often energy. Those concepts are powerful when their physical conditions apply. They should not define all recurrence.

The program treats vibration as a specialization:

$$\text{Vibration} \subset \text{Recurrence}.$$

Amplitude may inspire recurrence prominence; frequency may inspire recurrence density; phase may inspire relational alignment; harmonics may inspire nested ratios. The correspondences are construction aids, not equivalences. A recurrence can be irregular in clock time, lack an equilibrium, replace its participants, or appear only under a nonchronological adjacency.

The recurrent failure in this research was to introduce recurrence and then immediately calculate a frequency. The frequency could be useful, but it collapsed the broader question before alternatives were allowed to form.

# Chapter Five

## Resonance Synergy Sympathy and Bleed

These terms remain distinct.

| Term | Operational meaning |
|---|---|
| Recurrence | return or preservation under a declared relation |
| Recursion | output or state participates in later production |
| Synergy | non-additive joint organization through mutual interfaces |
| Sympathy | cross-system susceptibility under compatible relational qualities |
| Resonance | preferential reinforcement or persistence under compatibility conditions |
| Dimensional bleed | sensitivity to qualities excluded or compressed by the current representation |

Recurrence resonance is tested by whether the presence or reintroduction of family $R_a$ changes the probability, prominence, organization, or persistence of $R_b$ beyond an appropriate conditional null. It is not defined as matching frequency.

Failure to damp can motivate investigation, but direct driving, stored capacity, feedback, parametric excitation, reduced dissipation, environmental input, and detector error come first. Dimensional bleed is not a reservoir invoked to repair incomplete accounting.

# Chapter Six

## Observation Artifact and Actual Change

The project treats Actual Physics as continuously changing for the purpose of avoiding an assumed steady state. An observation is a physical and representational collapse of some portion of that change. Its assigned event boundary, identity, cause, and dimensions remain provisional.

An artifact is not automatically an error. It is a structure produced jointly by the underlying process, measurement, sampling, representation, and analysis. Some artifacts are nuisances. Others reveal how a frame partitions change. The first duty is to determine which.

The recurrence record therefore separates observation, association, and characterization. Observations are retained records. Associations are hypotheses about relations among them. Characterizations are revisable descriptions such as impact, occurrence potential, detectability, and reversibility.

# Chapter Seven

## Order Without Privileging Time

Chronology is indispensable for provenance and blind isolation. It is not the only possible adjacency and need not be the primitive physical order. Two records can be adjacent by actor, category, geography, network path, configuration, transformation, or detector accessibility while far apart in calendar time.

Precausal language should not be confused with retrocausality. A precausal proposal asks whether some ordering relation is prior to, or not exhausted by, a spacetime causal representation. Retrocausality asserts influence backward in a time order. The first does not entail the second.

The method records event order under each declared index before making causal claims. If an alternative adjacency improves prediction, it first establishes an operational relation. It does not prove that chronology is unreal.

# Part II

## The Labyrinth

# Chapter Eight

## Preserve the Useless

The Labyrinth retains apparently useless scalars, residuals, categories, missingness structures, transformations, operators, adjacency systems, and failed candidates. Neutral identifiers such as $\lambda_{0001}$ reduce premature semantic attraction.

“Preserve the useless” is an archival instruction, not a claim that every fragment deserves analysis forever. Storage and active inclusion are separate. A fragment can be retained while excluded from the current model. Reactivation requires a new prospective branch and cannot retroactively become blind evidence.

Preservation protects against present-frame blindness. It also increases multiplicity. The Labyrinth must therefore retain search provenance with the same care as values.

# Chapter Nine

## Fragments Families and Modes

A recurrence fragment is a local relation that may not yet support a stable family. A family groups fragments under frozen equivalence rules. A recurrence mode is a repeatable organization that can appear in several surface forms while retaining declared structure.

Mode language must not import vibrational ontology. In the 1995 experiment, modes are clusters in constructed feature geometry. Cross-resolution mode families are mappings between calendar-day and equal-event cluster organizations. They are not physical excitations.

Promotion from fragment to family requires more than repeated visual similarity. It requires a typed comparison, null-relative evidence, stability under nearby perturbations, and prospective survival.

# Chapter Ten

## Plural Adjacencies

An adjacency relation specifies which observations are neighbors for an operation. Chronological neighbors are one choice. File-order neighbors may differ from event-time neighbors. Actor-shared records, country pairs, semantic similarity, graph edges, and common transformations create others.

For adjacency $A_k$, define a neighborhood $N_k(x)$. A recurrence statistic is conditional on $k$:

$$R_k(x) = \Phi(x, N_k(x)).$$

Agreement across adjacencies can indicate transportable structure. Disagreement can reveal which ordering created the result. Combining adjacencies into one scalar too early destroys this diagnostic.

# Chapter Eleven

## Recurrence Topology

Topology here refers to representational connectivity: loops, branches, boundaries, fragmentation, joining, splitting, reconnection, symmetry, and nested structure. It is not automatically literal spatial topology.

Two observations can have different components and scalar values yet share a graph motif. Approximate graph matching, persistence summaries, or category-aware morphisms may define their equivalence. Each method introduces its own collapse and computational bias.

Topology is especially useful when recurrence identity survives component replacement. It is also vulnerable to threshold choice: a small change in edge definition can change connected components sharply. Response across thresholds should be reported as a surface rather than as one favored graph.

# Chapter Twelve

## Splitting Joining and Reconnection

The project generalizes the structural inspiration of splitting and joining without claiming a String-Theory mechanism. A family may split

$$\Lambda_a \to \left(\Lambda_b, \Lambda_c\right)$$

or join

$$\left(\Lambda_b, \Lambda_c\right) \to \Lambda_a .$$

The recurrent object may be the transformation type, not the endpoint. Reconnection occurs when participants change while a larger pattern remains approximately preserved.

Operators must specify directionality, allowed substitutions, conservation or loss, and the null frequency of similar transformations. A visually compelling split is not evidence without a comparison class.

# Chapter Thirteen

## Relational Alignment

Temporal phase is alignment within a periodic temporal model. Relational alignment generalizes the question: do two families occupy compatible positions under a declared adjacency, transformation, or interface?

Two families can be aligned by actor topology, opposed geographically, unrelated chronologically, and compatible under an operator-defined path. These relations should remain a profile until evidence justifies a scalar summary.

Alignment must be distinguished from association. Alignment specifies a structured correspondence. Association reports dependence. Either can occur without the other under a chosen model.

# Chapter Fourteen

## Nested Ratios and Interference

Nested recurrence asks whether returns occur within returns or whether recurrence separations maintain stable ratios. Integer harmonic ratios are not assumed. Ratios can be empirically discovered and tested on held-out data.

Interference-like behavior occurs when two recurrence families jointly amplify, suppress, invert, fragment, join, or create a third family. Linear superposition is not presumed. The interaction operator must be estimated and compared with an independence or coupling null.

Because interaction searches multiply quickly, the candidate family and outcome must be frozen before confirmatory testing. Otherwise ordinary model flexibility can impersonate relational discovery.

# Chapter Fifteen

## Duality and Projection Hidden Recurrence

Recurrence duality is a candidate equivalence between different representations whose recurrence structure is preserved under a translation. It borrows a mathematical question from physics without borrowing the physical interpretation.

Projection-hidden recurrence occurs when a relation disappears under coarse representation but remains visible at another resolution. Aggregation-created recurrence is the converse: the apparent relation appears because grouping manufactured it.

Both must be tested. Fine event code, base code, root code, and broad category can produce different recurrence surfaces. No resolution is automatically the truth.

# Chapter Sixteen

## Recurrence Surfaces

A sequence diagram $R_1 \rightarrow R_2 \rightarrow R_3$ can conceal branching and context. A recurrence surface

$$W\left(R, D_1, D_2, \ldots\right)$$

records how recurrence changes across dimensions, frames, thresholds, or interventions. Folds, boundaries, holes, stable regions, and bifurcations are descriptions of the constructed surface.

The surface is useful when its local features predict behavior under new perturbations. It is misleading when geometry is treated as physical space merely because it is plotted.

# Chapter Seventeen

## A Spectrum Without Frequency

A generalized recurrence spectrum decomposes observations by relational separation, topology, prominence, persistence, alignment, nested ratio, adjacency, and transformation type. It need not use temporal frequency.

The spectrum is a registry of distinguishable families, not necessarily a linear basis or energy distribution. Its components may overlap and may not be orthogonal. Dimensional bleed is expected unless independence is demonstrated.

Neutral spectrum identifiers protect early work from semantic selection. Interpretation follows prospective survival.

# Chapter Eighteen

## Relations Among Recurrences

Once families $R_1, \ldots, R_n$ exist, their relations become data. One can study transformations among motifs, equivalence classes of transformations, and relations among equivalence classes. This is recursive research on recurrence.

Every level adds selection and potential aliasing. The hierarchy must retain a downward map to its source observations and a record of losses. If a higher-order relation cannot be reconstructed or independently tested, it remains exploratory compression.

# Part III

## The 1995 Development Experiment

# Chapter Nineteen

## Why GDELT

The GDELT event archive offers large-scale coded observations with actors, countries, event categories, geography, tone, conflict-cooperation measures, sources, mentions, articles, and missingness. It is rich enough to support competing representations and common enough to expose ordinary data-production artifacts.

GDELT is not a detector of a physical substrate. It is an information system produced by events, reporting, collection, coding, and storage. Recurrence found within it first belongs to that coupled system.

The 1995 archive was chosen as development material while later years were withheld. The scientific value comes from the separation, not from assuming 1995 is special.

# Chapter Twenty

## The Raw Archive

The registered source contains 1,780,524 records and 57 fields in one 1995 file. Exact identity is preserved by size and cryptographic hashes. The raw archive remains external to later Recovery Point packages because of its size, but its identity is registered.

Raw does not mean interpretation-free. The fields already encode GDELT's event model and collection process. The raw archive is simply the earliest retained source for this experiment.

The reconstruction later verified the allowed year, exact member, row count, and schema before producing derived artifacts. No later-year data were required.

# Chapter Twenty One

## The Dimensional Atlas

The Atlas preserves seven outputs: raw summary, calendar-day features, equal-event features, country-pair lift, event-root transitions, actor-field missingness patterns, and a narrative. It widens the representational surface before candidate reduction.

The original Atlas generator was not recovered. RP05 reconstructed behavior that reproduced all seven retained outputs exactly in the declared environment. Exact agreement supports operational reproduction but does not prove recovery of original source or authoring process. The narrative is retained by explicit byte copy because its generation history is unavailable.

This distinction is central to the volume: behavior can be reconstructed while historical knowledge remains incomplete.

# Chapter Twenty Two

## Competing Segmentations

Calendar-day groups preserve institutional time boundaries but vary in event count. Equal-event groups stabilize count but vary in elapsed time. The incomplete final group contains 524 events and remains preserved but excluded from frozen equal-5,000-event scoring.

Agreement across the two segmentations can reduce dependence on one boundary system. It does not eliminate time structure, source order, event density, or shared features. Competing segmentations are probes, not independent universes.

Future sensitivity should vary window size, offset, overlap, scaling, missingness policy, and field subsets. Stability should be reported across the surface rather than as a chosen best window.

# Chapter Twenty Three

## Neutral Scalars and Descriptors

Sixteen neutral scalarizations were derived from entropy, categorical resolution, cooperation-conflict composition, actor-action asymmetry, media intensity, and inherited measures. Six recurrence descriptors then represented nearest return, nested recurrence, indexing separation, mode identity, adjacent-configuration divergence, and mutual-nearest recurrence.

Neutral labels reduce semantic overfitting but do not make scalars independent. Two formulas can share fields, aggregation, or constraints. Dependency should be tested algebraically, statistically, informationally, geometrically, interventionally, and across recurrence frames.

Each scalar is a central tendency relative to a construction. Residuals, distributions, missingness, and outliers remain part of the object.

# Chapter Twenty Four

## The Frozen Candidate Set

Eight candidate identifiers are frozen: four cross-resolution mode families $\Lambda_{0001}$ through $\Lambda_{0004}$ and four auxiliary candidates $\Lambda_{0101}$, $\Lambda_{0102}$, $\Lambda_{0103}$, and $\Lambda_{0201}$.

The candidate file fixes formulas, scalers, centroids, radii, thresholds, nulls, seeds, and decision rules for the inherited branch. Its embedded commitment is retained unchanged. Corrections to prose about candidate count do not change its bytes.

Freezing does not make a candidate true. It makes a later failure interpretable.

# Chapter Twenty Five

## Findings and Their Limits

Four cross-resolution mode mappings had standardized centroid distances from 1.805 to 2.651. Sequential adjacency distances were lower than row-permutation null means, with large negative z-scores. Mutual-nearest proportions exceeded independent-feature permutation nulls. Nineteen event-root codes passed the retained count threshold with median self-transition lift 13.3546.

The preliminary nulls are intentionally destructive. They establish that the data contain organization absent from those null worlds. They do not isolate unknown recurrence physics. Temporal persistence, reporting mechanisms, source batching, category imbalance, windowing, clustering geometry, and coding continuity remain viable explanations.

These findings justify prospective testing. They do not justify ontological language.

# Chapter Twenty Six

## The Blind Wall

The first held-out year is 1996. Through RP07 and this volume, it remains unopened. The wall protects the distinction between a rule developed on 1995 and a rule that survives new data.

Blindness is an information-flow property, not the absence of a filename on one screen. Code, configuration, notes, parameter choices, and human memory can leak outcome information. The audit must record what was accessible to whom and when.

Opening a year is irreversible. It can remain useful for exploration afterward, but it cannot become blind again.

# Chapter Twenty Seven

## Branch A and Branch B

Branch A applies the unchanged RP02 candidate system to 1996. No frame-shaking choice, later interpretation, or new feature may alter it while retaining the inherited blind claim.

Branch B continues development on 1995: stronger nulls, new adjacency systems, frame shaking, operator development, and alternative representations. It must create a separate commitment before using any unopened data.

Branch separation preserves creativity without contaminating confirmation. Results may later be compared, but their evidentiary histories remain different.

# Chapter Twenty Eight

## Leakage and Adaptive Choice

Adaptive choice enters through fields, thresholds, cluster count, metrics, windowing, outlier handling, nulls, stopping, and interpretation. Neutral names do not remove it. Search logs and candidate histories must expose it.

A leakage audit checks code, configuration, cache, notebooks, filenames, outputs, and communication for held-out information. A failed blind run does not permit discretionary tuning. Material changes create a new branch.

The same discipline applies to narrative. Knowing that a family corresponds to a political event can influence which candidate seems meaningful. Interpretation is delayed until recurrence survives.

# Part IV

## Null Worlds and Sensitivity

# Chapter Twenty Nine

## Why One Null World Fails

A null world states which structure would remain if the candidate relation were absent. Different nulls preserve different properties. Global row permutation destroys chronology, local persistence, source order, and episode structure at once. Rejection can therefore be unsurprising.

The question is not whether a result defeats any null. It is which plausible ordinary mechanisms remain after a graduated sequence of increasingly realistic nulls.

Every statistic should be paired with a null-preservation statement. Without it, a z-score conceals the comparison being made.

# Chapter Thirty

## The Graduated Null Program

The null ladder begins with destructive diagnostics and advances toward worlds preserving more relevant structure.

| Stage | Preserves | Tests against |
|---|---|---|
| N0 | marginal ranges only | gross structure and implementation errors |
| N1 | rows but not order | sequence dependence |
| N2 | local blocks or within-day composition | long-range organization beyond local persistence |
| N3 | actor country category or source marginals | structure beyond composition |
| N4 | degree missingness or intensity topology | higher-order organization beyond known network form |
| N5 | chronological autocorrelation or spectrum | nonchronological and nonlinear relations |
| N6 | representation and detector constraints | transfer beyond the measurement architecture |

A candidate that fails at a realistic stage is not rescued by success against an earlier destructive null.

# Chapter Thirty One

## Order Preserving Nulls

Block permutation retains local sequences while changing their larger arrangement. Within-day permutation preserves daily membership while breaking file adjacency. Circular shifts preserve each series' internal structure while breaking cross-series alignment. Spectrum-preserving surrogates retain conventional autocorrelation while altering nonlinear phase relations.

Each design has failure modes. Block length can manufacture or erase recurrence. Circular shifts can wrap incompatible boundaries. Spectrum preservation assumes the selected time-series representation is appropriate. Sensitivity across null parameters is required.

# Chapter Thirty Two

## Marginal Topological and Source Nulls

Actor-frequency, country-frequency, event-category, and source-intensity preserving nulls ask whether recurrence exceeds composition. Degree-preserving graph rewiring asks whether motifs exceed local network structure. Missingness-topology nulls test whether absent fields explain the family.

Source order deserves special attention because GDELT file adjacency may preserve collection or batching processes. A relation that disappears when source ordering is controlled may still be operationally real in the information system, but its interpretation narrows.

# Chapter Thirty Three

## Synthetic Injections

Synthetic recurrence with known amplitude, duration, topology, bleed, and cross-resolution mapping should be injected into realistic null worlds. Recovery probability estimates power. False localization reveals operator bias. Missed injections bound what a null result can say.

Injections must pass through the same preparation, representation, search, and reporting pipeline as real data. Analysis-level injection alone cannot test upstream loss.

The injected pattern should not resemble only the candidate favored by the developer. A family of positive controls exposes selective sensitivity.

# Chapter Thirty Four

## Multiplicity and Search Burden

The Labyrinth searches fields, resolutions, adjacencies, metrics, thresholds, modes, transformations, and frames. The number of nominal tests understates the adaptive search burden because choices depend on earlier results.

Multiplicity control can use preregistered families, holdout data, hierarchical testing, false-discovery procedures, or selective-inference methods suited to the design. No correction repairs undisclosed search.

The most important record is often the path: what was tried, discarded, renamed, and promoted before the candidate froze.

# Chapter Thirty Five

## Sensitivity Surfaces

A candidate should be mapped across nearby choices in segmentation, aggregation, scaling, distance, threshold, missingness, and outlier treatment. Report a stability surface rather than the best point.

Broad stability may support transport. Narrow localization may reveal a meaningful regime or an overfit. The distinction requires a frozen prediction about where the localization should recur.

Sensitivity analysis is not permission to retune the confirmatory candidate. It belongs to Branch B or to a preregistered robustness family.

# Chapter Thirty Six

## Null Results as Results

A null can mean no effect, inadequate power, wrong operator, excessive collapse, or regime dependence. Injection recovery and calibration distinguish these possibilities.

All failed candidates remain in the archive with their definition, expected result, observed result, and reason for retirement or continued uncertainty. A failed blind candidate must not be renamed and counted as a new success on the same data.

The Labyrinth is credible only if it can lose.

# Part V

## Frame Shaking

# Chapter Thirty Seven

## Register the Artifact First

Frame shaking begins with a registered artifact, not a preferred alternate dimension. The artifact record fixes its source, initial representation, score, uncertainty, null, and discovery history.

Only then may the frame vary. Otherwise the researcher can search for a frame that makes a desired pattern large and mistake the search result for independent evidence.

Artifact identity may itself be provisional, but changes are versioned. A changed artifact creates a changed question.

# Chapter Thirty Eight

## Tool Lineages

Developmental Tools detect and characterize recurrence qualities. The formal 33 Tools and their extensions describe axes of frame perturbation and response. The lineages are related but must not be silently merged or renumbered.

Every tool output records tool identity, parameters, input and output hashes, dimensional quality, and role: discovery, characterization, validation, or interpretation. A tool used after freezing cannot modify the inherited scorer.

Tools are ways of asking, not entities discovered in nature.

# Chapter Thirty Nine

## Axes of Perturbation

The frame can be shaken through projection, lexicon, dimension set, adjacency, aggregation, operator, anchor, context, resolution, interaction representation, and tolerated collapse. Each axis should have a declared neighborhood and permissible range.

Perturb one condition at a time where possible, then test interactions among perturbations prospectively. Preserve null, contradictory, dispersive, and failed frames.

The full planned shake family is the denominator. Reporting only the strongest frame hides selection.

# Chapter Forty

## Response Geometry

For artifact $a$ and frame parameters $\theta$, define a multicomponent response

$$\rho_a(\theta) = (e, u, n, s, o, p),$$

where the components may represent effect size, uncertainty, null-relative score, cross-resolution stability, outlier dependence, and predictive transfer. This is an example schema, not a universal vector.

The response geometry maps where the artifact persists, dissolves, changes sign, splits, or merges. A scalar maximum is inadequate because two frames can have the same score and different uncertainty or transfer.

# Chapter Forty One

## Frame Affinity

Frame affinity is the conditional compatibility between an artifact and a region of frame space. It should remain a profile before summary. Narrow affinity can indicate construction dependence. Broad affinity can indicate robustness but may also reflect a trivial invariant.

Neighborhoods must be defined before comparing stability. A frame cannot be called robust merely because the search selected nearby alternatives after seeing results.

# Chapter Forty Two

## Candidate Alternate Dimensions

An alternate dimension in this research is a reproducible region of frame space in which an artifact becomes coherently distinguishable and produces prospective consequences. It is not an extra spatial axis and not an ontological claim.

The candidate must specify lexicon, dimensions, operators, adjacency, bleed assumptions, tolerances, translations, resources, and failure conditions. A single favorable coordinate system is insufficient.

# Chapter Forty Three

## Frame Completeness

No frame is presumed complete. Completeness is typed: descriptive, relational, recursive, recurrence, interventional, accounting, and translational completeness can differ.

Operational incompleteness is established when two states equivalent within the frame’s declared tolerances respond differently to a common frozen intervention and ordinary explanations are bounded. A verbal statement that the frame “misses something” is not enough.

# Chapter Forty Four

## Aliasing and Dimensional Bleed

Aliasing occurs when distinct recurrent systems produce effects the current frame cannot distinguish. Surface, intent, measurement, projection, interface, temporal, session, and cross-domain aliases have different causes.

Dimensional bleed describes sensitivity to excluded or compressed qualities. It should be estimated by changing the representation and testing how the result transports. It is not a label applied to every unexplained residual.

Related-but-different systems should remain distinct when their response profiles diverge. Convenient merging can erase the discriminator the research needs.

# Part VI

## Recovery Points

# Chapter Forty Five

## Why Recovery Points Exist

Long research conducted across sessions is vulnerable to informational collapse. A latest summary can omit failed paths, branch reasons, source identity, and unfinished work. A Recovery Point preserves enough evidence and structure for a capable new researcher to continue without relying on conversation memory.

An RP is not a polished narrative of inevitable progress. It is a checkpoint containing controls, backlog, composite, citations, chapters, code, metadata, failures, and manifests.

# Chapter Forty Six

## Immutable History and Living Interpretation

Every released RP is immutable historical evidence. A later RP may extend, qualify, conflict with, correct, supersede, or retain an unresolved alternative. It does not rewrite the parent.

This protects evidence of how the research actually developed. It also prevents a later vocabulary from being projected backward as though it had always governed.

The living interpretation resides in the newest accepted RP and its external continuation controls. Historical mistakes remain inspectable.

# Chapter Forty Seven

## Composites Chapters and Evidence

The recovery composite states the central question, boundary, findings, branches, and next actions. It is intentionally compressed. DC chapters preserve dependencies, alternatives, reasoning, and evidence that cannot safely fit in the composite.

Frozen artifacts retain data, code, candidates, outputs, and logs. Legacy archives retain earlier checkpoints. No single layer is complete by itself.

A continuation begins by reading the successor instructions, backlog, composite, citation register, hierarchy, then the chapters and evidence relevant to the next development.

# Chapter Forty Eight

## Citations Manifests and Commitments

Evidence classes include primary artifacts, derived artifacts, interpretive documents, commitment evidence, and external references. A hash proves byte identity, not correctness. A narrative explains evidence but cannot replace it.

The lineage chain is

$$\text{source} \rightarrow \text{transformation} \rightarrow \text{output} \rightarrow \text{interpretation}\,.$$

Manifests make package membership verifiable. Candidate commitments make pre-outcome definitions verifiable. Citation labels bind claims to artifacts. All three serve different purposes.

# Chapter Forty Nine

## Change Impact and Typed Consistency

New findings propagate forward across definitions, mathematics, data, code, candidates, nulls, validation, interpretations, chapters, and metadata. The impact record explains what changes and what remains untouched.

Consistency is typed. Lexical consistency, dimensional consistency, algebraic consistency, statistical consistency, causal compatibility, provenance consistency, and operational compatibility can disagree. A system should not be harmonized by deleting real conflicts.

# Chapter Fifty

## Preserving Failure

RP06 reproduced six failures in the historical Pre-Crypto laboratory: unsafe archive-member acceptance, failure to create a clean freeze directory, overwrite of time-dependent freeze evidence, acceptance of invalid candidate bytes, a false unlock log after state-write failure, and a missing entropy field that stopped feature construction.

RP07 created a separate prospective hardened path. Twenty-seven of twenty-seven tests passed. Exact candidate validation, safe staged extraction, content-addressed freezing, separate receipts, fixture-only transactions, and deterministic reconciliation addressed five failures. Two entropy definitions remain separate unresolved branches. Parquet output remains environment-blocked in the recorded runtime.

The later success does not turn the historical failures into passes. Their preservation teaches what the control words “immutable,” “blind,” and “transactional” must mean operationally.

# Chapter Fifty One

## Branches and Emergent Intents

Branches receive stable identifiers, parent developments, triggers, relationships, scopes, dependencies, evidence, status, merge conditions, exclusion conditions, and next actions. Nonprimary branches remain visible until formally disposed.

An emergent intent is a repeated operating pressure not represented in the intent registry. It may reveal a hidden scalar, coupled systems, aliasing, a tool limitation, a resource boundary, or simply a useful new rule. The pressure is preserved before its explanation is chosen.

Adding an intent changes the system that produced it. Each adoption is therefore an intervention with expected and unintended consequences.

# Chapter Fifty Two

## The RP0 Through RP07 Case

| Recovery Point | Principal contribution | Retained limitation |
|---|---|---|
| RP0 | prompt raw archive Atlas and blind lab | broad program not yet integrated |
| RP01 | first frozen 1995 candidates | incomplete archived implementation |
| RP02 | reproducible core and candidate commitment | preliminary nulls and limited representation |
| RP03 | frame shaking Tool lineages and characterization axes | protocol largely unexecuted |
| RP04 | governance chapters citations backlog and continuity | raw-to-Atlas generator absent |
| RP05 | exact seven-file Atlas reconstruction | original source and narrative generation unrecovered |
| RP06 | offline lab integration and six reproduced failures | unsafe historical path and unresolved feature |
| RP07 | prospective hardening with 27 passing tests | entropy branch unresolved Parquet blocked 1996 unopened |

The progression demonstrates why newer is not simply truer. Each RP carries forward earlier evidence while narrowing or correcting claims.

# Chapter Fifty Three

## Next and Prompt

The instruction Next resolves the latest committed RP, continuation prompts, consolidated intents, and next-stage control. It executes the first incomplete authorized stage. It does not waive blindness, acceptance, or user-decision gates.

The instruction Prompt returns or creates the finalized portable Prompt 1 and Prompt 2 handoff after RP completion. Prompt 1 recovers and audits the immutable parent. Prompt 2 performs the conditional next development and successor gate.

Automatic prompt generation reduces continuity loss, but no prompt may invent a final archive identity before packaging and saving are complete.

# Part VII

## Prospective Validation

# Chapter Fifty Four

## The Unchanged Scorer

The next unresolved critical development is to implement and dry-run the unchanged frozen scorer interface without opening 1996. The dry run should use synthetic or permitted 1995-derived fixtures and verify that every candidate formula, scaler, centroid, threshold, null, seed, stream rule, exclusion, and decision rule reaches the scoring boundary unchanged.

Interface validation must distinguish the complete file hash from the embedded definition commitment. Both identities matter. A valid handoff does not authorize a real unlock.

# Chapter Fifty Five

## The Blind Result Packet

When a held-out year is eventually authorized, the result packet should include candidate-by-candidate outcomes, preregistered statistics, null distributions, multiplicity adjustment, effect sizes, uncertainty, exclusions, failures, environment, code identity, candidate commitment, and permanent opened-data status.

Every candidate is reported. A family is not omitted because it failed. Unexpected results remain blinded until the predefined release procedure permits interpretation.

# Chapter Fifty Six

## Drift Across Years

Technology, media, politics, reporting, vocabulary, coding, and data volume change across years. A candidate may fail because the recurrence was overfit, because the system changed, or because the measurement process changed.

Drift analysis follows the first blind score. It must not be used to retune the inherited candidate on the same year. Later sequential years can test whether a frozen drift model improves transport.

# Chapter Fifty Seven

## Cross Domain Translation

Surviving operators may be compared across event data, physical systems, economics, or Tarot research. Shared mathematical shape establishes neither a shared mechanism nor shared ontology.

Translation requires source and target entities, units, operators, preserved relations, broken meanings, domain-specific nulls, and a prospective target prediction. Failed mappings remain evidence about where the analogy ends.

Market and other outcome layers remain locked until the relevant operator is frozen for that branch.

# Chapter Fifty Eight

## Handoff to Physical Experiments

Analytical recurrence can generate candidates for Volume Five’s physical criterion. It cannot establish a physical effect by itself. A physical test must prepare conventionally equivalent states, retain a frozen relational difference, apply a common intervention, and predict differential ordinary outcomes.

Independent detectors, calibration, randomization, resource accounting, environmental controls, and conventional explanations remain mandatory. A relational candidate that never changes prospective physical susceptibility has no demonstrated physical leverage.

# Chapter Fifty Nine

## Stop Conditions

Stop or branch when a blind boundary is uncertain, a candidate identity fails, a null was changed after outcome exposure, search history is incomplete, a source cannot be verified, a result depends on one unregistered frame, or an ordinary mechanism predicts the finding.

Do not advance merely to create a newer RP. An RP is justified by a documented stopping point and complete carry-forward, not by sequence alone.

If no candidate survives realistic nulls and held-out data, report the failure. The Labyrinth remains useful as an audited record of what the chosen representations could not support.

# Chapter Sixty

## Using the Research Commons

The Substrate Cosmology website provides public navigation, recovery archives, investigation routes, evidence boundaries, and replication records. Begin with the volume links on the home page, then open Resources for the Recovery Point archives and continuation materials.

Use the evidence graph and replication index to distinguish a proposal from a result. Use the investigation workbench for bounded questions. A simulation is a reasoning aid unless its page identifies empirical inputs and validation. A public file is inspectable, not thereby endorsed or confirmed.

For recurrence work, preserve the exact RP parent, branch, candidate commitment, data boundary, null family, frame ensemble, and evidence status in any contribution. Link negative results and competing characterizations to the same question rather than creating a success-only account.

The dedicated Volume Ten manual will document all website routes, roles, lifecycle controls, moderation boundaries, continuity surfaces, and exports.

# Conclusion

Recurrence begins as a question of identity under change. A familiar scalar may return while the underlying organization changes. A relational organization may return while every familiar scalar changes. A periodic waveform is one answer, not the definition of the question.

The Labyrinth preserves enough representational diversity to let alternative relations become visible. Its discipline is equally important: neutral naming, complete provenance, realistic null worlds, sensitivity surfaces, frame-search accounting, freezing, blindness, and failure preservation.

The 1995 experiment has produced structured exploratory candidates and a recoverable research architecture. It has not produced blind validation or new physics. Its most mature result may presently be methodological: the project learned that preserving a commitment requires more than a hash, that an unlock log is not a transaction, that exact output reproduction is not source recovery, and that unresolved feature meanings must remain branches rather than be selected for convenience.

The next step is not interpretation. It is an unchanged scorer interface, followed only under explicit authorization by the first blind evaluation. Whatever survives will still face stronger nulls, drift, independent replication, and the measurement criteria of Volume Five. Whatever fails remains part of the research record.

# Appendix A

## Recurrence Claim Record

| Field | Required content |
|---|---|
| Claim ID | stable identifier and version |
| Carrier | observations relations graphs or transformations compared |
| Frame and dimensions | declared representational context |
| Adjacency | chronological actor categorical geographic network or other |
| Identity rule | what may vary and what must be preserved |
| Metric and tolerance | typed comparison and justified threshold |
| Discovery history | searches choices failures and adaptations |
| Null worlds | preserved and destroyed properties |
| Multiplicity family | denominator and correction |
| Sensitivity | nearby parameter and representation surface |
| Candidate status | exploratory frozen blind tested failed or retired |
| Evidence | source transformation output and interpretation links |
| Nonclaims | conclusions the result does not support |

# Appendix B

## Operator Record

Every operator records domain, codomain, admissible inputs, frame, dimensions, adjacency, scale, tolerance, symmetry, directionality, invariance, missingness behavior, uncertainty propagation, null family, composition rules, loss, failure conditions, implementation identity, and evidence status.

Operator families include state return, transition return, mutual recurrence, topology, persistence, surface or interface, cross-resolution mapping, duality, splitting, joining, reconnection, relational alignment, nested ratio, and interference.

# Appendix C

## Null World Specification

1. Name the candidate claim.
2. State the ordinary mechanism the null represents.
3. List every property preserved.
4. List every property destroyed.
5. Specify generation algorithm, seed, count, and dependence.
6. Validate marginals and structural constraints.
7. Inject positive controls and measure recovery.
8. Estimate false positives across the full search pipeline.
9. Register the multiplicity family.
10. Freeze escalation and stopping rules.

# Appendix D

## Frame Shake Registry

| Field | Required content |
|---|---|
| Artifact | frozen source and initial evidence |
| Frame ID | stable identifier |
| Perturbation axis | projection lexicon dimensions adjacency aggregation operator anchor context resolution interaction or collapse |
| Change | exact parameter or transformation |
| Neighborhood | preregistered nearby frames |
| Expected response | preservation dissolution inversion split merge or unknown |
| Response profile | effect uncertainty null score stability outlier dependence transfer |
| Search status | planned exploratory or confirmatory |
| Selection burden | registered family and adaptivity |
| Outcome | complete including null and failed frames |

# Appendix E

## Blind Scoring Checklist

- Verify the exact frozen candidate file and embedded commitment.
- Verify the held-out dataset identity without opening content before authorization.
- Confirm the scorer matches the frozen formulas and environment contract.
- Confirm exclusions, nulls, multiplicity, seeds, and decisions are fixed.
- Complete the leakage audit.
- Preserve stdout, stderr, environment, hashes, and invocation.
- Report all candidates and failures.
- Mark the year permanently opened after access.
- Separate scoring from interpretation.
- Do not retune the inherited branch.

# Appendix F

## Recovery Point Checklist

1. Resolve and freeze the exact parent identity.
2. Increment the RP index without reuse.
3. Recover cited assets and open development items.
4. Audit coverage and classify every gap.
5. Preserve historical wording and parent bytes.
6. Propagate new implications forward by typed impact.
7. Add or update DC chapters.
8. Update successor instructions backlog composite citations and hierarchy.
9. Audit blindness and branch separation.
10. Validate recovery by a new-reader test.
11. Generate and verify manifests.
12. Test the archive and machine-readable records.
13. Record deficiencies closed retained and introduced.
14. Save as a new artifact beside the parent.
15. Finalize the external Prompt 1 and Prompt 2 handoff.

# Appendix G

## RP0 Through RP07 Findings Ledger

| Finding | Status | Interpretation ceiling |
|---|---|---|
| Four cross-resolution mode families | frozen 1995 candidates | exploratory organization in the constructed information system |
| Sequential adjacency compression | frozen preliminary result | differs from destructive row-order null |
| Mutual-nearest recurrence | frozen preliminary result | cross-feature organization under the declared metric |
| Event-root self-transition lift | frozen preliminary result | categorical persistence possibly driven by ordering and domain process |
| Seven-file Atlas reproduction | exact reconstructed behavior | operational reproduction not original-source recovery |
| Six Pre-Crypto failures | reproduced historical evidence | preserved defects in inherited implementation |
| Prospective hardening | 27 of 27 fixture tests pass | operational readiness for further integration only |
| Pooled versus mean-side entropy | unresolved alternatives | neither may enter frozen scoring without a new branch |
| Parquet output | environment-blocked | no claim of serialization success |
| 1996 score | not performed | no blind validation claim |

# Appendix H

## Glossary

**Actual Physics:** the unknown physical target, kept distinct from every representation.

**Adjacency:** a declared rule specifying which records or relations are neighbors for an operation.

**Aliasing:** distinct systems producing effects the current frame cannot distinguish.

**Blind wall:** the information boundary separating development data from unopened validation data.

**Candidate commitment:** a cryptographic identity of definitions frozen before a declared test.

**Dimensional bleed:** sensitivity to qualities excluded or compressed by the current representation.

**Frame affinity:** the conditional compatibility between an artifact and a region of frame space.

**Frame shaking:** systematic perturbation of representation after an artifact is registered.

**Labyrinth:** the provenance-bearing archive of provisional fragments representations failures and relations.

**Null world:** a generated comparison preserving declared ordinary structure while removing a candidate relation.

**Recurrence:** return or preservation of characterized organization under a declared representation and tolerance.

**Recursion:** repeated self-application in which outputs or states participate in later production.

**Recovery Point:** an immutable checkpoint that preserves evidence reasoning branches failures and unfinished work.

**Relational alignment:** structured correspondence under a declared adjacency or transformation without requiring temporal phase.

**Resonance:** preferential reinforcement or persistence under compatibility conditions; not limited here to frequency matching.

# Appendix I

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