From Labeled Cubes to Physics: Time, Latency, Absence, and the Emergence of Dynamical Worlds

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This paper extends an anonymous cube-based system of mathematical generation into a speculative framework for the emergence of physics. The earlier static construction begins with labeled cubic cells whose panels, seams, and junctions possess distinguishable marks but no assigned mathematical meaning. Mathematics appears only retrospectively, after stable structures have been generated, tested, and recognized. The present extension introduces ordered change, local interaction, persistent histories, latent cells, and structured absences. A time-dependent cube is represented not as one object with a changing numerical parameter, but as a provenance-complete sequence of states. Physics begins only when change becomes constrained by locality, limited propagation, persistence, interaction, and invariance. Two further primitive classes are proposed. Latent or “magic” cubes influence manifest states without being directly readable, creating a possible generative route toward complex-number-like transformations and hidden dynamical structure. Missing cubes represent genuine absence rather than blank occupancy and may generate deficit, sign, boundary, defect, and particle-like behavior. The combined system contains four primitive modes: being, becoming, latency, and absence. Familiar mathematics and physics are introduced only in a quarantined recognition ledger after their operational structures have independently emerged. The resulting framework provides a program for investigating whether dynamical laws, particles, fields, conservation principles, complex structure, relativity-like behavior, and quantum-like branching can arise from anonymous finite histories rather than being inserted as prior theory.

Keywords: time-dependent cubes, emergent physics, latent states, missing cubes, structured absence, mathematical ontogenesis, dynamical systems, complex numbers, defect propagation, conservation, delayed recognition, provenance.

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1. Introduction

A static universe of completely labeled cubes provides a vast space of formal possibility. Each cube contains six panel sites, twelve seam sites, and eight junction sites. Distinct labels may be assigned independently to these positions, producing an enormous finite population of possible configurations. When anonymous encounter rules act on pairs of cubes, still larger spaces of possible operations arise. Regularities may then be discovered through repeated interaction, recursive wrapping, operational comparison, and retrospective mathematical recognition.

A static population, however, does not yet provide physics.

Physics concerns not only what configurations exist, but how configurations change, how changes propagate, what remains persistent through change, and which relations constrain possible histories. A system that simply indexes one cube after another has sequence, but not necessarily time. A system in which every cube can change arbitrarily and instantaneously has variation, but not necessarily dynamics. A system containing changing structures but no locality, persistence, interaction, or invariance may generate motion-like imagery without generating a physical world.

The extension from mathematics to physics therefore requires more than attaching a time variable to a labeled cube.

The primitive object must become a **history-bearing cell**.

Instead of representing a cube only by a complete labeling, the system records a sequence:

C[0] → C[1] → C[2] → …

Each state contains the complete externally visible labeling, orientation, contact relations, hidden registers, and provenance available at that stage. The arrows do not initially mean physical evolution. They indicate only that one recorded state follows another under a permitted update procedure.

The integer-like index is likewise not initially called time. It is an anonymous ordering of update stages. The system must earn the interpretation of time by generating behaviors for which this order becomes operationally indispensable.

A time-like structure begins to emerge when:

- earlier states constrain later states;
- local changes require several updates to reach distant regions;
- recurring processes provide internal clocks;

- some histories cannot be reversed from available information;
- persistent objects can be followed through multiple changes;
- different observers reconstruct related but nonidentical temporal records.

The transition may be summarized as:

ordering → change → propagation → persistence → interaction → invariance → physical time

The cube system should preserve the same methodological discipline used in mathematical generation:

Generate first, recognize second, and name last.

No physical interpretation should be built into the genesis ledger. An update should not initially be called motion. A persistent pattern should not initially be called a particle. A distributed influence should not initially be called a field. A preserved signature should not initially be called energy, momentum, or charge. A branching history should not initially be called quantum.

These descriptions belong only in a later recognition ledger, after exact operational correspondences have been established.

The present proposal adds two further kinds of primitive structure to the manifest changing cube.

The first is the **latent cube**, informally called the magic cube. It is not directly readable in the same way as an ordinary cell, yet it alters future transformations. It may exist in a hidden layer, between recorded stages, inside an encounter, or as a transformation capacity rather than a manifest object. Latent cubes provide a possible operational route toward mathematical structures that cannot be expressed adequately by visible states alone.

The second is the **missing cube**. This is not a cube carrying a blank label. It is the absence of a cube at an address at which occupancy is possible or expected. Missing cubes create structured voids, deficits, boundaries, holes, moving vacancies, and historical discontinuities. Their behavior may become as generatively important as the behavior of present cubes.

The full primitive world therefore contains four modes:

manifest presence, ordered change, latent influence, and structured absence.

These may be described philosophically as:

being, becoming, latency, and absence.

The proposal is that broad regions of mathematics and physics may emerge from stable relations among these four modes.

The static labeled cube supplies possible form.

Ordered updates supply development.

Latent cubes supply operative structure that is not immediately manifest.

Missing cubes supply active absence.

Local encounters among these structures may generate persistent patterns, propagating disturbances, defect motion, conserved signatures, internal clocks, observer-dependent histories, and branching outcomes. Only after such behaviors emerge should they be compared with known mathematics and physics.

The aim is not to disguise established physical theories in cubic notation. It is to ask a more primitive question:

What kinds of physical law become recognizable when anonymous cells are permitted to persist, change, disappear, remain latent, interact locally, and preserve complete histories?

2. From Configuration to History

The static cube is defined by its complete state at one stage. The temporal cube is defined by the relation among many such states.

A history record may be written:

H(C) = ⟨C[0], C[1], C[2], …, C[n]⟩.

The angle brackets indicate an ordered record and carry no imported mathematical meaning in the genesis ledger. Every transition must be accompanied by a replayable update record.

The history contains more than successive external labelings. At each stage it may include:

- the marks at all panel, seam, and junction sites;
- the cube's orientation;
- all contacts with neighboring cubes;
- the state of hidden or interior registers;
- latent influences active during the update;

- occupied and missing neighboring addresses;
- the rule version applied;
- every branch taken;
- the complete transformation trace.

The physically relevant primitive may therefore be the history rather than the individual state.

Two cubes with identical present markings may behave differently because their histories differ. Conversely, two cubes with different internal histories may display the same future behavior under every available probe. The system must preserve both state and provenance until operational testing justifies a weaker description.

2.1 Events

An event is the smallest recorded difference between consecutive stages.

If a seam mark changes, a contact is formed, a cube disappears, or a latent influence becomes manifest, the ledger records an event.

An event may involve:

- one site;
- several sites on one cube;
- sites spanning a contact boundary;
- the orientation of a cube;
- the creation or deletion of a contact;
- the occupation or vacancy of an address;
- the appearance or concealment of a latent cell;
- the wrapping or unwrapping of an assembly.

The system should not assume that all events are equally elementary. An event that appears primitive at one descriptive level may later be resolved into a sequence of smaller events at a deeper level.

2.2 Update Order

The genesis ledger requires an unambiguous ordering of updates, but that ordering need not immediately correspond to one universal physical time.

Several update arrangements are possible:

- every cell updates together;
- one cell updates at a time;
- local regions update independently;
- contact events trigger updates;
- different wrapped levels update at different rates;
- updates are partially ordered rather than globally sequenced.

These alternatives should be explored rather than decided by physical prejudice.

A single universal update count may make implementation easier, but the system should not infer that nature possesses an external master clock. Internal time-like behavior must be recognized from relations among generated processes.

2.3 Internal Clocks

A recurring process can function as an internal clock when its successive stages provide reproducible markers for other processes.

Suppose a stable assembly repeats a pattern:

$\mathbf{K_0 \rightarrow K_1 \rightarrow K_2 \rightarrow K_3 \rightarrow K_0}$.

Another process may then be described relative to these recurring stages.

The recognition of a clock becomes stronger when:

- the cycle persists under environmental changes;
- several clocks can be compared;
- clock rates vary predictably under encounters;
- clocks can be transported through assemblies;
- different observers reconstruct systematic relations among clock records.

No numerical duration need be introduced at the start. Duration may emerge as comparison among repeated histories.

2.4 Persistence Through Change

A static cube remains the same because its state is unchanged. A physical object must remain identifiable even while its state changes.

The system therefore needs an operational criterion for historical persistence.

A sequence of states may be treated as one continuing object when:

- each state is generated from the preceding state by a local rule;
- a stable signature persists;
- disturbances are repaired;
- a recognizable boundary is transported;
- a construction lineage remains continuous;
- the sequence interacts with other structures as one continuing entity.

Persistence is not exact identity of markings. It is continuity of generative organization.

This opens the possibility that the same persistent structure may occupy different cubes at different stages. The physical object would then be a moving or propagating pattern rather than a material cell.

2.5 History as the Basis of Physical Identity

A particle-like object may therefore be defined anonymously as a persistent localized history.

A field-like object may be a distributed history whose local states alter the transitions of embedded patterns.

A force-like relation may be a systematic alteration of one history by another.

An inertial-like property may be resistance of a history to changes in its propagation pattern.

These familiar interpretations must remain absent from the genesis ledger. But their possible operational ancestors are already visible.

The central ontological shift is:

The static cell is a state-bearing object; the temporal cell is a history-bearing process.

Physics begins when persistent processes become more fundamental than isolated configurations.

3. Conditions for a Physical World

Arbitrary state change is not enough to produce physics. A generated world must develop constraints that make histories structured, predictive, and mutually coupled.

3.1 Locality

The next state of a cell should depend on a bounded context.

The context may include:

- the cell's current external marks;
- its hidden register;
- cells in direct contact;
- nearby vacancies;
- active latent structures;
- a bounded segment of history.

A local rule need not be spatial in the familiar sense. Locality means only that the update does not require unrestricted access to the entire world.

Locality creates the possibility of independently evolving regions, interfaces, propagation fronts, and causal-like structure.

3.2 Limited Propagation

A local change should require repeated encounters to affect distant regions.

Suppose one cube changes at stage t. A neighboring cube may respond at stage t + 1, a more distant cube at t + 2, and so forth.

The maximum distance reached per update may become a discoverable propagation bound.

Such a bound would later support physical interpretation as a limiting signal speed, but it must first arise as a property of the update system.

Without limited propagation, distant events can coordinate instantly, and the operational meaning of spatial separation becomes weak.

3.3 Persistent Patterns

Some patterns must survive many updates.

Persistence may take several forms:

- static persistence, where the same marks remain;
- cyclic persistence, where a finite sequence repeats;
- translational persistence, where a pattern reappears at neighboring addresses;
- reconstructive persistence, where damage is repaired;
- genealogical persistence, where descendants preserve a defining signature;
- statistical persistence, where aggregate behavior remains stable despite local variation.

Persistent patterns provide candidates for physical entities.

3.4 Interaction

Persistent histories must alter one another when their neighborhoods overlap.

An interaction is operationally significant when the combined future differs from the futures produced in isolation.

The ledger should compare:

- history of A alone;
- history of B alone;
- history of A and B in contact.

The difference constitutes the interaction record.

Interactions may produce:

- deflection;
- fusion;
- separation;
- exchange of marks;
- creation of vacancies;
- activation of latent structures;
- altered clock cycles;
- persistent entanglement of future histories.

The terminology remains neutral until later recognition.

3.5 Invariants

A physical world requires properties that remain unchanged across significant classes of events.

An invariant may be:

- a total mark count;
- a parity-like distinction;
- a cyclic signature;
- a boundary feature;
- a relation among several histories;
- a quantity transferred between regions but not created or destroyed;
- a transformation class preserved by every permitted update.

The system should not define conservation laws in advance. It should search histories for signatures that remain stable despite visible change.

A conserved signature becomes especially important when it constrains future possibilities.

3.6 Reversibility and Irreversibility

Some updates may be exactly reversible. Others may erase distinctions.

The ledger should distinguish:

- fully reversible transitions;
- transitions reversible only with hidden history;
- transitions reversible only before wrapping;
- transitions whose branches merge;
- transitions that destroy reconstructible information.

Irreversibility may emerge when several earlier states produce the same later state and the missing distinction cannot be recovered from accessible records.

This provides a possible route toward thermodynamic-like behavior without inserting entropy as a primitive quantity.

3.7 Observer Construction

An observer should not initially be an external human viewpoint. It should be a generated assembly that:

- receives local inputs;
- preserves records;
- compares successive records;
- generates predictions;
- distinguishes some states but not others;
- interacts with the world being observed.

Different observers may possess different interfaces, histories, and clocks.

The same world event may therefore produce different internal records in different observers.

Observer-relative physics becomes possible when systematic translations relate these records.

3.8 The Minimal Physical Chain

The emergence of physics may follow the chain:

ordered updates → local dependence → finite propagation → persistent history → interaction → invariant → internal clock → observer-relative description

Each transition adds a necessary form of organization.

A system may exhibit some of these features without exhibiting all of them. Such partial worlds should be preserved. They may later be recognized as limited dynamical systems, computational processes, statistical models, or nonphysical mathematics.

Physics is not generated by the mere presence of time labels. It emerges when histories become locally constrained, mutually consequential, and governed by persistent operational regularities.

4. Three Classes of Cubic Existence

The temporal extension becomes substantially richer when the system distinguishes not merely different labels, but different modes of occupancy.

A site in the evolving world may be:

- occupied by a directly readable cube;

- influenced by a latent cube;
- unoccupied despite being available for occupancy;
- forbidden from occupancy;
- historically occupied but presently empty.

These distinctions should be primitive in the genesis ledger because they produce operationally different histories.

The three main cube classes are:

- manifest cubes;
- latent cubes;
- missing cubes.

The words “manifest,” “latent,” and “missing” are descriptive conveniences. Their exact meanings must be specified through permitted interactions.

4.1 Manifest Cubes

A manifest cube occupies a declared world address and exposes readable panel, seam, and junction marks.

It may:

- contact neighboring manifest cubes;
- respond to probes;
- change its markings;
- alter orientation;
- join assemblies;
- become latent;
- disappear and leave a missing address;
- emerge from a previously missing or latent condition.

A manifest cube is not necessarily permanent. Manifestation refers only to its current accessibility within the world’s ordinary reading procedures.

Two manifest cubes may be distinguished by:

- labeling;
- orientation;
- contact history;
- hidden register;
- ancestry;
- response to standardized probes.

4.2 Latent Cubes

A latent cube influences transitions without being directly readable by the ordinary external probes available to manifest cubes.

It may occupy:

- a hidden layer associated with one world address;
- a contact interface between cubes;
- an interval between two manifest update stages;
- the concealed interior of a wrapped assembly;
- a distributed relationship among several manifest cubes;
- a branch that has not yet become manifest.

A latent cube should not be defined merely as an ordinary cube whose labels happen to be concealed. Its operational role must differ from that of a hidden manifest cube.

The defining property is:

A latent cube contributes to future outcomes while lacking an independently readable manifest state under the current probe system.

The evidence for a latent cube is therefore indirect. It is inferred from reproducible differences in manifest histories.

Suppose two apparently identical manifest contexts produce different outcomes. If the difference persists and can be predicted from an additional hidden record, the system may represent that record as a latent cube.

This does not immediately justify metaphysical claims about invisible objects. It provides a compact operational representation of hidden causal capacity.

4.3 Missing Cubes

A missing cube is not an object. It is a structured absence at an address where occupancy is defined.

The ledger must distinguish several forms of absence.

Vacant address:
No cube is presently located there.

Historical vacancy:
A cube previously occupied the address and has departed or disappeared.

Expected vacancy:
A template, assembly rule, or recurrent structure predicts occupancy, but no cube is present.

Forbidden address:
The current rules prohibit occupation.

Unresolved address:
The system does not possess enough information to determine whether the address is occupied.

These absences may have different effects on neighboring histories.

4.4 Blank Is Not Missing

A cube carrying one or more blank marks remains a manifest cube.

A blank mark is a readable state.

A missing cube is nonoccupancy.

This distinction is as important as the distinction between zero objects and no object, or between an empty container and the absence of a container. Those familiar comparisons belong only to later recognition, but they illustrate why the genesis ledger must preserve the difference.

4.5 Deleted Is Not Missing

A deleted cube leaves a provenance trace.

Its address may now be vacant, but the ledger records:

- the identity of the prior occupant;
- the transition that removed it;

- whether its marks were transferred;
- whether a latent structure remained;
- whether the vacancy can be refilled;
- whether the deletion can be reversed.

A world containing a historical vacancy differs from an otherwise identical world in which the address was never occupied.

If future behavior depends on that difference, history has become physically active.

4.6 Forbidden Is Not Empty

A forbidden address cannot be occupied under the active rule set.

A vacant address may be occupied by a later event.

This difference permits the system to generate rigid boundaries and dynamical vacancies without defining either in advance.

4.7 Interconversion

The three classes should be permitted to transform into one another.

Possible anonymous transitions include:

manifest → latent
A readable cube ceases to appear directly but continues to influence future events.

latent → manifest
A hidden influence becomes a readable cube or pattern.

manifest → missing
A cube disappears, leaving a vacancy.

missing → manifest
A vacancy becomes occupied.

latent → missing
A hidden influence ceases without becoming manifest.

missing → latent
A vacancy acquires hidden transition capacity without visible occupancy.

These transitions create a developmental world in which presence, hidden influence, and absence are dynamically coupled.

5. The Operational Meaning of a Magic Cube

The phrase "magic cube" is useful because it emphasizes that the cube appears to do more than an ordinary readable object. But the framework must replace magic with reproducible operational behavior.

A candidate magic cube should satisfy at least three conditions.

First, it must alter manifest outcomes.

Second, its effects must recur under reproducible conditions.

Third, the effects must not be reducible to an unrecorded ordinary manifest cube.

The magic cube is therefore not an appeal to unexplained action. It is a placeholder for a form of effective structure whose state is not represented in the ordinary manifest description.

5.1 Hidden State Versus Latent Operation

A hidden state is a concealed property of an otherwise manifest cube.

A latent operation is more radical. It may exist only as a relation among transitions.

For example, a latent cube may have no meaningful state when isolated. Its identity may consist entirely in the transformation it produces when inserted between two manifest stages.

Such a cube is not best understood as a hidden object carrying unknown labels. It is an anonymous transformation-bearing interval.

5.2 Interstitial Cubes

An interstitial cube occupies the transition between two manifest states:

A → L → B

where L is not recorded by ordinary manifest observation but is required for exact replay.

If A → B cannot be reproduced directly under the permitted manifest rules, yet A → L → B can be reproduced, then the latent stage has explanatory necessity within the genesis system.

This creates an operationally meaningful intermediate object.

5.3 Relational Latency

A latent cube may belong neither to one object nor to one address.

It may be associated with a relation between two manifest cubes.

Suppose cubes A and B behave one way when separated and another way after a particular encounter, even after they are later separated and restored to their earlier visible markings.

The persistent difference may be stored in a relational latent structure connecting their histories.

The latent object is then not located in either cube alone. It belongs to the pair or assembly.

5.4 Distributed Latency

A latent state may be distributed across several cubes so that no local probe can recover it.

Only a coordinated encounter involving the entire assembly may reveal the hidden structure.

This would create a form of nonlocal description without requiring instantaneous nonlocal influence. The latent state may have been created locally and then distributed through a finite history.

5.5 Latent Capacity

A manifest cube may carry the capacity to undergo a transformation that is not visible in its present marks.

Two cubes with the same visible state may differ in what they can become under a later encounter.

The difference may be encoded as latent capacity.

A physical analogy may later describe such capacity as potential, phase, internal state, or stored energy. The genesis ledger records only the divergence of future response.

6. From Latent Cycles to Complex-Like Structure

Imaginary and complex numbers should not be inserted by labeling a latent cube with a familiar symbol.

They should be recognized only if the generated transformations exhibit the required operational organization.

A plausible route begins with cyclic transformation.

6.1 Four-Stage Return

Suppose a promoted transformation Q acts repeatedly on a stable object family.

Starting from state A, the system records:

A → B → C → D → A.

Assume the four stages are operationally distinct.

Further suppose:

- A and C are manifest under ordinary probes;
- B and D are latent under those probes;
- C produces a response opposed to that of A;
- D produces a latent response opposed to that of B;
- four applications of Q restore the starting state.

The cycle may be written anonymously as:

Q(A) = B
Q(B) = C
Q(C) = D
Q(D) = A.

No known mathematical label is needed to generate or verify this cycle.

6.2 Opposition

The relationship between A and C must itself be earned operationally.

They may be called opposed when:

- their encounters with a standard probe produce complementary outputs;
- placing them together restores a neutral template;
- one reverses a displacement caused by the other;
- one cancels a persistent signature carried by the other;
- a transformation exchanging them preserves all other tested structure.

Opposition should not be introduced merely by naming one positive and one negative.

6.3 Latent Opposition

Likewise, B and D may form a latent opposed pair.

Their opposition may become visible only through later effects on manifest states.

The four-stage structure then contains two distinct axes of behavior:

- manifest opposition;
- latent opposition.

A generated state may contain contributions from both.

6.4 Paired Description

Suppose every state in a fertile world can be reconstructed from two components:

- one manifest component;
- one latent component.

A record may then take the anonymous form:

X = [m ; ℓ]

where m and ℓ are generated coordinates rather than imported numbers.

The transformation Q may exchange and oppose these components in a repeatable way.

Only after such behavior is established should the recognition ledger compare the system with complex-number-like structure.

6.5 Why Latency Matters

If only the manifest states A and C are retained, the transformation appears to jump between an object and its opposite.

The intermediate stages are lost.

The latent states preserve the full cyclic structure.

In this sense, imaginary-like structure may arise not as an artificial extension of ordinary quantity, but as the necessary representation of intermediate transformation phases omitted by a purely manifest description.

6.6 Rotation Without Prior Geometry

The four-stage cycle may later be recognized as rotation-like, but no plane or angle need be inserted initially.

The recognition becomes justified if the transformation satisfies operational properties such as:

- repeated quarter-stage action;
- preservation of a combined signature;

- reversal after two applications;
- restoration after four;
- compatibility with composition;
- consistent action on paired components.

Geometry would then be a retrospective interpretation of transformation structure.

6.7 Beyond Four Stages

Other latent cycles may produce different extension structures.

A six-stage, eight-stage, or nonclosing transformation may generate other operational systems.

The framework should not privilege the four-stage cycle merely because it resembles known complex mathematics.

It should search all compact recurrent transformations and later determine which known structures, if any, they support.

6.8 Complex-Like Physics

If four-stage latent cycles occur in evolving assemblies, they may contribute to:

- periodic propagation;
- paired wave components;
- phase-sensitive encounters;
- cancellation and reinforcement;
- orientation-dependent transformations;
- hidden intermediate histories.

These could later support recognition of complex-valued physical descriptions.

The system would then explain why complex structure appears useful: it records transformation phases that cannot be represented within the manifest layer alone.

7. Missing Cubes as Structured Absence

The missing cube introduces a different form of extension.

A latent cube adds hidden operative structure.

A missing cube removes manifest occupancy while preserving an address and possibly a historical expectation.

Absence becomes generative when future transitions depend on where and how a cube is missing.

7.1 The Vacancy Record

A vacancy record should contain:

- the vacant address;
- neighboring occupied addresses;
- the identity of any former occupant;
- the event that created the vacancy;
- whether the vacancy is permitted, expected, or forbidden;
- whether latent influence remains;
- all later movements or transformations of the vacancy.

The vacancy is therefore a positive ledger object even though no manifest cube occupies the address.

7.2 Relative Deficit

A missing cube becomes deficit-like only relative to a reference structure.

Suppose a recurring assembly template normally contains a cube at address p.

If one realization lacks that cube, the ledger records a departure from the template.

The deficit is not an intrinsic property of the vacancy alone. It is relational:

actual assembly compared with recurrent template.

This provides a noncircular route toward signed or negative-like structure.

7.3 Cancellation Through Completion

Suppose assembly A contains an extra cube relative to a template, while assembly B contains a corresponding vacancy.

An encounter may transfer the extra cube into the vacancy, restoring both assemblies or producing a complete combined structure.

If this completion behavior is reproducible, the recognition ledger may later identify the extra and missing configurations as opposed quantities.

The opposition is established by restoration, not by prior numerical labeling.

7.4 Moving Vacancies

Consider a row of occupied addresses with one vacancy.

A neighboring cube moves into the vacancy, leaving its former address empty. Repetition produces:

vacancy at p_0 → vacancy at p_1 → vacancy at p_2 → …

The cubes move in one direction while the vacancy appears to move in the opposite direction.

The vacancy therefore has a history, position, propagation rate, and interaction behavior even though it is not a manifest cube.

A moving absence may become operationally particle-like.

7.5 Vacancy Interaction

Two vacancies may:

- merge;
- repel through local update rules;
- trap a manifest pattern;
- terminate one another by reconstruction;
- form a stable pair;
- alter propagation through an assembly;
- bind to latent structures.

Such behaviors could later be recognized as defect dynamics.

7.6 Vacancy Creation and Removal

A local update may transform a fully occupied pattern into a pattern containing vacancies.

Conversely, vacancies may disappear when neighboring structures reorganize.

The ledger should record whether:

- vacancies are created singly;

- they appear in linked pairs;
- their creation preserves another signature;
- their removal releases manifest or latent structure;
- a vacancy can disappear without trace.

Stable creation and removal rules may provide the operational ancestry of particle-production-like or annihilation-like processes.

8. Absence and the Emergence of Topology

Missing cubes can alter the global organization of an assembly without adding any new manifest object.

This makes structured absence a natural source of topology-like behavior.

8.1 Cavities

Removing one or more cubes from the interior of a filled assembly may create a cavity.

The cavity may be:

- isolated;
- connected to the exterior;
- linked to another cavity;
- deformable through vacancy motion;
- stable under local rearrangement.

A cavity is defined by surrounding occupancy rather than by its own material content.

8.2 Tunnels

A connected sequence of vacancies may create a passage through an assembly.

Two assemblies may contain the same number of occupied cubes but differ in whether such a passage exists.

If no permitted local deformation can remove the passage without breaking the external boundary or creating new vacancies, the tunnel possesses a persistent global signature.

8.3 Components

Missing cubes may separate an assembly into disconnected occupied regions.

Conversely, filling one vacancy may join two regions.

Connectivity becomes a dynamical property controlled by occupancy and absence.

8.4 Boundary Formation

A vacancy adjacent to a manifest cube creates an exposed interface.

Large vacancy regions therefore generate boundaries.

Boundary behavior may determine:

- which encounters are permitted;
- how disturbances reflect or transmit;
- where latent states accumulate;
- how wrapped interfaces are formed;
- whether internal regions can communicate.

8.5 Topological Recognition

The recognition ledger may identify topology-like structure when properties of vacancies and connections remain stable under broad classes of local rearrangement.

The required evidence includes:

- reproducible deformation procedures;
- preserved global signatures;
- obstruction records;
- classification of transformations that do and do not change the signature;
- translation into familiar topological descriptions.

The holes and tunnels should not be named mathematically until their operational persistence is established.

9. Missing Cubes and Signed Structure

Structured absence may also generate number-like and algebra-like extensions.

9.1 Templates as Reference States

A signed distinction requires a reference.

A recurring complete assembly can serve as an anonymous template T.

Another assembly may differ from T by:

- one additional occupied address;
- one missing occupied address;
- several additions and vacancies;
- substitutions that combine both.

These differences can be stored as transformation records relative to T.

9.2 Opposite Transformations

Suppose transformation A adds one cube at a designated address and transformation B removes one cube from that address.

If applying A after B, or B after A, restores the template under stated conditions, the transformations are operationally opposite.

The recognition ledger may later compare this relation with additive inverse structure.

9.3 Balance

An assembly may carry several extras and several vacancies.

Local transformations may move, combine, or cancel these departures while preserving a total balance signature.

The balance need not initially be numerical. It may be encoded as a canonical residual pattern after every permitted cancellation has been performed.

9.4 Emergent Zero

A zero-like structure may be recognized when a configuration:

- represents no residual departure from the template;
- remains unchanged by addition of balanced extra-vacancy pairs;
- acts neutrally in an encounter family;
- can be reconstructed through several independent cancellation pathways.

Zero is therefore not simply the label of an empty site. It emerges as the stable equivalence class of balanced deviation.

9.5 Negative-Like Objects

A vacancy pattern becomes negative-like when it participates systematically in:

- opposition;
- cancellation;
- ordered displacement relative to a reference;
- reversible transformations with extra occupancy;
- conserved balance.

The familiar mathematical interpretation is justified only after this behavior develops.

10. Manifest, Latent, and Missing Interactions

The richest dynamics will occur when the three cube classes transform one another.

10.1 Manifest–Manifest Encounters

Two ordinary cubes may:

- exchange marks;
- reorient;
- bind;
- separate;
- generate a wrapped assembly;
- create vacancies;
- produce latent structure.

10.2 Manifest–Latent Encounters

A manifest cube exposed to a latent cube may:

- change without direct visible contact;
- acquire future transformation capacity;

- convert the latent cube into a manifest state;
- redistribute the latent influence;
- become part of a phase-like cycle.

10.3 Manifest–Missing Encounters

A manifest cube adjacent to a vacancy may:

- move into it;
- duplicate into it;
- expose a boundary mark;
- be transformed by the vacancy's history;
- become latent while filling the address;
- propagate the vacancy elsewhere.

10.4 Latent–Latent Encounters

Two latent structures may:

- cancel;
- reinforce;
- become manifest;
- produce a stable relational state;
- generate a new latent cycle;
- alter the rules governing later manifestation.

10.5 Latent–Missing Encounters

A vacancy may carry latent capacity.

For example, an empty address may be predisposed to admit only certain cubes or to transform any cube that enters.

The absence then acts as more than geometric room. It becomes a structured potential for future events.

10.6 Missing–Missing Encounters

Vacancies may join into larger defects, separate, form boundaries, or create topologically persistent absence patterns.

These interactions can produce global organization using nonoccupancy alone.

10.7 Conversion Table

The full transition grammar may include:

manifest + manifest → manifest
manifest + manifest → latent
manifest + manifest → missing pattern
manifest + latent → manifest variant
manifest + missing → displaced manifest + displaced vacancy
latent + latent → manifest pair
latent + missing → activated vacancy
missing + missing → extended defect

The arrows denote generated outcomes, not physical equations.

11. The World State

A complete evolving world must record more than its manifest occupancy.

At update stage t, the world record may be written:

W[t] = ⟨M[t], L[t], V[t], R[t]⟩

where:

- M[t] is the complete manifest configuration;
- L[t] is the complete latent configuration;
- V[t] is the complete vacancy and forbidden-address configuration;
- R[t] is the relevant provenance and active rule record.

These symbols are anonymous bookkeeping devices.

11.1 Manifest Projection

An embedded observer may access only part of M[t].

It may have no direct access to L[t], and it may interpret parts of V[t] only through boundary effects.

The observer's world description is therefore a projection of the full genesis state.

11.2 Hidden Completeness

The full world record need not be available to any embedded observer.

It is maintained by the external genesis ledger for reproducibility.

This distinction allows the system to compare:

- complete update determinacy;
- observer-level apparent branching;
- hidden-state explanations;
- genuinely persistent branching even in the full record.

11.3 Effective Laws

An observer may derive compact rules governing its accessible projections.

These rules may be highly successful even though they omit latent and missing structure.

Such rules become effective laws.

Different observers may discover different effective laws because they possess different interfaces, scales, or histories.

11.4 Full and Effective Physics

The framework therefore permits two levels of later recognition:

Full recognition:
A mathematical or physical interpretation of the complete manifest-latent-vacancy history.

Effective recognition:
A successful interpretation based only on an observer's accessible projection.

The difference may help explain why a familiar physical formalism appears probabilistic, complex-valued, nonlocal, or incomplete from within a restricted observational layer.

12. A Developmental Hypothesis

The static cube universe generated formal structures through anonymous arrangement, encounter, wrapping, and recognition.

The temporal extension adds a second developmental sequence:

presence → change → history → persistence → interaction → propagation → invariant → observer → physics

The latent extension adds:

hidden influence → recurrent intermediate phase → paired description → complex-like structure

The missing extension adds:

vacancy → deficit → opposition → cancellation → boundary → defect → topology and particle-like structure

The combined developmental system becomes:

manifest state + latent capacity + structured absence + ordered history

From these, the recognition ledger may eventually identify:

- number-like systems;
- complex-like transformation spaces;
- discrete geometry;
- topology;
- dynamical systems;
- wave mechanics;
- defect particles;
- fields;
- conservation laws;
- statistical behavior;
- observer-dependent spacetime descriptions;
- quantum-like contextual branching.

None of these outcomes is guaranteed.

The proposal is that manifest, latent, and missing cubes provide sufficiently distinct primitive modes to make their emergence possible without placing their familiar mathematical names into the genesis grammar.

The next task is to specify how propagation, motion, particles, waves, fields, and conservation could arise operationally from these evolving worlds.

13. Propagation and the Birth of Motion

A changing label is not yet motion.

Motion emerges only when a persistent operational pattern appears at successive world addresses while preserving enough structure to be recognized as one continuing history.

Suppose a localized pattern occupies address p_0 at one update stage, address p_1 at the next, and address p_2 afterward:

$$\mathbf{P[p_0, t_0] \rightarrow P[p_1, t_1] \rightarrow P[p_2, t_2].}$$

The primitive ledger does not say that one object traveled. It records three local configurations linked by update rules.

A motion-like interpretation becomes justified when:

- each later pattern is generated locally from the earlier one;
- a characteristic signature persists;
- no equally good account treats the stages as unrelated creations;
- the pattern interacts continuously with its surroundings;
- disturbances to one stage alter later stages;
- the complete history can be replayed.

Physical identity therefore lies in the continuity of transformation rather than in the persistence of one material cube.

13.1 Carrier Motion and Pattern Motion

Two distinct forms of motion should be separated.

Carrier motion occurs when one manifest cube changes address while retaining its own identity.

Pattern motion occurs when successive cubes assume a recurring state while earlier cubes return to background states.

In pattern motion, the visible entity moves even though no individual cube traverses the entire path.

This distinction is important because many physical phenomena may later be recognized as propagating organization rather than transported substance.

13.2 Vacancy Motion

Vacancy motion provides the clearest example.

Suppose address p_0 is empty and p_1 is occupied. The cube at p_1 moves into p_0, making p_1 vacant. The vacancy has moved from p_0 to p_1.

Repeated updates produce a vacancy history even though absence itself has no material carrier.

The manifest cubes and the vacancy may propagate in opposite directions.

Such histories could later be recognized as hole-like transport, defect motion, or opposite-sign response.

13.3 Latent Propagation

A latent structure may also propagate.

A cube at one address acquires hidden capacity, transfers that capacity to a neighbor, and returns to an ordinary manifest state. The neighboring cube then transfers it onward.

No directly readable object moves, but a reproducible influence travels.

A latent propagation history may later become manifest at a distant address.

This creates a distinction among:

- movement of occupancy;
- movement of visible pattern;
- movement of vacancy;
- movement of latent capacity.

A mature physics-like system may contain all four.

13.4 Displacement

Displacement should not initially be represented numerically.

It begins as a relation between world addresses occupied by successive stages of one persistent history.

Repeated displacement patterns may later generate:

- direction classes;
- path equivalence;
- step counts;
- relative velocity-like measures;
- geometric coordinates.

Direction itself should be discovered from transformation consistency.

If repeated local changes carry patterns through distinguishable classes of neighboring addresses, those classes may later be interpreted as directions.

13.5 Rest

Rest is not the absence of all change.

A persistent structure may alter internally while maintaining the same external address and boundary signature.

It is operationally at rest relative to a reference assembly when:

- its address remains fixed;
- its relation to the reference remains stable;
- its internal cycles do not produce net displacement.

Thus motion and rest are relational properties of histories.

13.6 Reference Structures

A claim that one pattern moves requires another pattern relative to which its address changes.

A large stable assembly may function as a reference structure.

Different reference assemblies may assign different displacement histories to the same pattern.

This opens the way toward observer-relative motion before any familiar mechanics is introduced.

14. Propagation Bounds and Causal-Like Order

Local update rules naturally create limits on how quickly a disturbance can spread.

Suppose one event alters a single cube at stage t.

If only direct neighbors may respond at stage t + 1, then cubes two contacts away cannot respond before a later stage.

The evolving world develops a propagation cone: a growing region of addresses that could have been influenced by the original event.

The term "cone" belongs to later geometric recognition. In the genesis ledger, it is simply a reachable-address record.

14.1 Reachability

For an event E, define the anonymous reachable region after k updates as all addresses whose states differ in at least one valid history because E occurred.

The system compares:

- a world history containing E;
- a matching history without E;
- the addresses at which the two histories first diverge.

This difference map reveals the propagation of influence.

14.2 Maximum Propagation Rate

If no influence travels more than a fixed number of contact steps per update, the world has a maximum propagation rate.

This rate need not be inserted as a universal constant.

It may arise from:

- the local reading radius;
- the order of updates;
- the need for intermediate latent stages;
- the structure of contact interfaces;
- the availability of vacancies.

Different classes of influence may have different rates.

A deeper rule may later reveal one shared maximum.

14.3 Precedence Without Global Time

When updates are local and partially ordered, one event may necessarily precede another without the world possessing one universal update sequence.

An event A precedes event B when every valid reconstruction of B requires a chain descending from A.

Other event pairs may lack a fixed order.

This could generate causal-like ordering before global time coordinates are introduced.

14.4 Simultaneity as an Observer Construction

Two distant events may be grouped into the same observer stage only through a synchronization procedure involving internal clocks and signal exchange.

Different observers may construct different stage groupings while agreeing on local precedence.

The recognition ledger may later compare such behavior with relativity-like simultaneity.

14.5 Horizon-Like Boundaries

An observer with finite history and finite propagation access cannot yet receive information from every region.

The boundary of accessible influence forms an operational horizon.

A horizon may arise from:

- finite propagation time;
- blocked interfaces;
- rapidly changing boundaries;
- latent barriers;
- expanding vacancy regions;
- irreversible loss of contact.

No spacetime geometry needs to be assumed at the start.

15. Persistent Localized Histories

A localized pattern that survives, propagates, and interacts is the natural anonymous precursor of a particle.

Such a pattern should be called a **persistent localized history** until stronger recognition is justified.

15.1 Localization

A history is localized when its distinguishing signature remains concentrated within a bounded neighborhood.

The exact neighborhood may move.

Localization may be tested by asking how much of the world must be read to distinguish the pattern from the background.

15.2 Persistence

Persistence requires more than repeated visual resemblance.

The history should maintain:

- a reproducible signature;
- continuity of local generation;
- characteristic responses to probes;
- recognizable interactions;
- lineage across update stages.

15.3 Mobility

Some localized histories remain fixed. Others propagate.

Mobility may depend on:

- surrounding labels;
- vacancy availability;
- latent phase;
- orientation;
- nearby defects;

- update order.

A localized history may move only through specific backgrounds. Its apparent properties are then relational rather than intrinsic.

15.4 Internal Cycle

A persistent localized history may contain a recurring internal sequence.

The internal cycle can function as:

- a clock;
- an orientation marker;
- a latent phase;
- a determinant of interaction outcomes.

Two otherwise similar localized histories may differ only in cycle phase.

This may later become recognizable as an internal degree of freedom.

15.5 Particle-Like Species

Operationally distinct families of localized histories may be classified by:

- propagation pattern;
- cycle length;
- interaction signature;
- response to vacancies;
- latent-state structure;
- preserved marks;
- behavior under reorientation;
- stability under collision.

These families may later receive particle-like interpretations.

15.6 Composite Histories

Several localized histories may bind into a larger persistent unit.

The composite may possess:

- a new propagation rate;
- new internal cycles;
- greater stability;
- reduced external visibility of its components;
- interaction signatures absent from its parts.

The system may therefore generate hierarchical physical entities through the same wrapping mechanism used for mathematical abstraction.

16. Collision and Interaction

Two persistent localized histories interact when their combined future cannot be reconstructed by independently extending their isolated histories.

The interaction region is the bounded neighborhood in which this divergence begins.

16.1 Scattering-Like Behavior

Two incoming localized histories may approach, overlap, and depart as two outgoing histories.

The outputs may differ in:

- direction;
- internal cycle;
- speed-like propagation rate;
- latent content;
- vacancy structure;
- species-like signature.

Repeated encounters under comparable conditions may produce stable outcome patterns.

16.2 Fusion

Two histories may merge into one persistent history.

The new history may preserve a combined signature or release additional propagating disturbances.

Fusion is operationally distinct from one history merely concealing the other inside a wrapped structure. Unwrapping and probe tests can distinguish these possibilities.

16.3 Fission

One localized history may split into two or more persistent descendants.

The descendants may share signatures constrained by the parent history.

A stable relation among parent and descendant signatures may later support conservation-like interpretation.

16.4 Annihilation-Like Events

A localized manifest history and an opposed vacancy or latent history may meet and cease to persist as localized objects.

Their prior signatures may reappear as distributed disturbances.

Nothing should be described as annihilated unless the ledger confirms that the localized structures disappear while some broader record of the event remains.

16.5 Pair Creation

A disturbance in the background may generate two linked localized histories.

The pair may possess opposed signatures or correlated latent phases.

A rule requiring paired creation would be especially significant because it suggests a preserved background balance.

16.6 Interaction Channels

The same incoming histories may produce several possible outcomes.

The branches may depend on:

- exact cycle phase;
- orientation;
- hidden register;
- local vacancy pattern;
- surrounding field-like state;
- unresolved branching.

A complete interaction signature includes every replayable channel.

17. Waves as Distributed Histories

A wave-like structure is a propagating pattern that is distributed across many addresses rather than localized in one bounded neighborhood.

17.1 Periodic Disturbance

Suppose a local state alternates through a recurrent sequence and induces neighboring cubes to enter the same sequence with delayed phase.

The result is a propagating periodic history.

The system need not initially contain amplitude, wavelength, or frequency as numerical quantities.

These may emerge from:

- size of mark deviation;
- address separation between repeating phases;
- update count between recurrences.

17.2 Manifest and Latent Components

A wave may alternate between manifest and latent phases.

At one update stage, the disturbance appears in readable marks. At the next, the manifest marks return to background while latent capacity transfers forward.

The full wave exists only in the combined manifest-latent history.

This provides a natural use for complex-like paired description.

17.3 Reinforcement

Two distributed disturbances may meet and produce a larger local deviation than either creates alone.

This may occur when their phases align.

17.4 Cancellation

Two disturbances may meet and temporarily restore the background pattern.

The histories may continue afterward, revealing that the apparent disappearance was phase-dependent cancellation rather than destruction.

17.5 Interference-Like Structure

A stable rule governing reinforcement and cancellation can generate intricate spatial patterns.

The recognition ledger may later identify interference-like mathematics if:

- combined outcomes follow from phase relationships;
- the disturbances remain recoverable after overlap;
- a paired latent-manifest description predicts the results;
- single-history and combined-history records differ systematically.

17.6 Standing Patterns

Oppositely propagating disturbances may produce a persistent distributed pattern whose visible nodes remain fixed while internal states cycle.

Such structures may act as:

- internal clocks;
- stable resonances;
- boundaries for localized histories;
- components of larger assemblies.

17.7 Dispersion

Different disturbance patterns may propagate at different rates.

A compact initial disturbance may spread because its component cycles separate over time.

The system may later recognize frequency-dependent propagation.

17.8 Solitary Propagation

Some distributed disturbances may maintain a stable localized shape while traveling.

These histories occupy the border between wave-like and particle-like behavior.

The cube world may therefore generate the relation between waves and particles before naming either category.

18. Fields as Conditions of Possible Transition

A field-like structure should not be defined merely as a number assigned to every cube.

That would import a mature mathematical representation too early.

Operationally, a field is a distributed condition that modifies local transition possibilities.

18.1 Background Rule Modulation

Suppose identical manifest cubes undergo different updates at different addresses because each address carries a persistent latent condition.

The distributed latent condition acts as a field-like background.

It may determine:

- which transitions are allowed;
- which branch is favored;
- the rate of internal cycles;
- the direction of propagation;
- the stability of vacancies;
- the interaction of localized histories.

18.2 Field Without Local Object

A field-like condition need not be represented by an additional manifest cube at every address.

It may exist as:

- latent site records;
- interface rules;
- distributed history;
- constraints generated by distant boundaries;
- properties of the contact network.

The physical effect lies in altered transition behavior.

18.3 Field Sources

A localized history may modify nearby transition conditions.

The modification may then propagate outward.

The localized history is a source-like structure if:

- its presence systematically changes surrounding update rules;
- the alteration decays, spreads, or persists reproducibly;
- removing the history changes the distributed condition;
- other histories respond to the altered region.

18.4 Back-Reaction

A field-like structure becomes dynamically coupled when the objects affected by it also alter it.

Without back-reaction, the field is merely an imposed background.

With back-reaction, the world contains mutual determination between localized and distributed histories.

18.5 Field Storage

A distributed condition may retain the effects of prior interactions even after the sources move away.

The world then stores history in its background.

This may later be recognized as field energy, memory, curvature, polarization, or another persistent medium-like state.

18.6 Multiple Fields

Different latent condition families may influence different transition classes.

They may interact, combine, or transform into one another.

A later recognition ledger may identify several field types, but their primitive distinction is operational: they modify different local possibilities.

19. Conservation as Persistent Transfer

A conserved quantity should not be inserted by assigning numerical values to cube labels.

Conservation should emerge from signatures that remain stable across complete histories despite local redistribution.

19.1 Signature Preservation

Let S be an anonymous procedure that reads a world state and produces a canonical record.

If

S(W[t]) = S(W[t + 1])

for every permitted update in a tested world, then S is a preserved signature.

The equality here means exact match of canonical records, not a prior numerical equation.

19.2 Local Transfer

A stronger physical interpretation arises when the preserved signature moves between regions.

One region loses a pattern while a neighboring region gains a corresponding pattern.

The total world signature remains fixed.

This distinguishes conservation from mere immobility.

19.3 Hidden Conservation

A manifest signature may appear not to be conserved because part of it becomes latent or is stored in a vacancy structure.

When all three layers are included, preservation may be restored.

Thus apparent nonconservation can reveal an incomplete ontology.

A manifest-only observer might infer creation or destruction where the full ledger records conversion among:

- manifest occupancy;
- latent capacity;
- structured absence;
- distributed disturbance.

19.4 Pair Balance

Opposed localized histories may be created or removed only in pairs.

A canonical balance record may remain unchanged even as the number of visible objects changes.

This can generate charge-like conservation without assigning charge values in advance.

19.5 Cycle Conservation

An internal cycle phase may be transferred during encounters.

One object's phase changes while another's changes oppositely, preserving a combined cycle signature.

19.6 Topological Conservation

A vacancy loop or tunnel may persist under every permitted local deformation.

Its signature is conserved not through local material count but through global organization.

19.7 Conservation and Law Discovery

Preserved signatures are powerful because they reduce possible futures.

If an encounter begins with a known signature, only outputs with the same canonical record are permitted.

Conservation therefore becomes both a descriptive and predictive law.

20. Inertia-Like Persistence

A propagating history may continue in the same pattern when undisturbed.

This behavior should not be inserted as a law. It should be discovered as a stable update regime.

20.1 Default Continuation

A localized history has inertia-like behavior when its next displacement and internal transition can be predicted from its recent history unless an interaction occurs.

20.2 Resistance to Change

Different persistent histories may require different sizes or durations of disturbance to alter their propagation.

Resistance may depend on:

- internal complexity;
- latent-cycle structure;
- binding among components;
- surrounding field state;

- vacancy distribution.

20.3 Memory Versus Inertia

Continuation may arise because the history explicitly stores its previous displacement.

Alternatively, it may arise from local structural rules that make continuation automatic.

The two mechanisms should be distinguished.

A recognition ledger may later interpret both through effective inertial mathematics, but their generative ancestries differ.

20.4 Composite Resistance

A bound assembly may resist change more strongly than its components.

This provides a route toward mass-like behavior as an emergent property of organized persistence.

20.5 Directional Resistance

A structure may respond differently to disturbances from different directions because of its orientation or internal seam organization.

The resulting inertia-like behavior may be anisotropic.

21. Force-Like Relations

A force-like relation appears when one persistent structure systematically changes another's propagation history without simply replacing it.

21.1 Contact Deflection

Two histories meet, exchange local marks or latent state, and depart along altered paths.

The repeated relation between encounter configuration and trajectory change may later be recognized as a contact force.

21.2 Mediated Influence

A source modifies a distributed field-like condition. A second object responds to that condition without direct contact with the source.

The full history remains local if the field modification propagates through successive updates.

21.3 Vacancy-Mediated Motion

A gradient-like distribution of vacancies may make movement easier in one direction than another.

A persistent object then changes its path because of structured absence.

21.4 Latent Mediation

A latent cube or distributed latent phase may carry influence between separated manifest histories.

The mediator may become manifest, remain hidden, or be absorbed.

21.5 Reciprocal and Nonreciprocal Interaction

Two objects may alter one another symmetrically, or one may alter the other without an equal reverse effect.

The system should not assume reciprocal force laws.

Reciprocity, where it appears, becomes a discovered structural regularity.

22. Energy-Like Structure

Energy should not be introduced as a primitive scalar label.

An energy-like concept may emerge as a conserved capacity for producing change.

22.1 Transformation Capacity

A cube or assembly may differ from another only in the range of future transformations it can generate.

This difference is stored capacity.

22.2 Conversion

Capacity may move among forms:

- manifest motion;
- internal cycle;
- latent state;
- field distortion;

- vacancy configuration;
- binding structure.

A canonical signature may remain constant across these conversions.

22.3 Work-Like Transfer

One history may lose transformation capacity while another gains it through an interaction.

The transfer may correlate with displacement or structural change.

22.4 Bound Capacity

A composite may require an input disturbance to separate.

The difference between the bound and separated histories may later be recognized as binding energy-like structure.

22.5 Distributed Capacity

A field-like state may retain the ability to alter future histories even when no localized source remains nearby.

This gives the distributed world an energy-like content.

22.6 Operational Recognition

A later energy interpretation becomes compelling only if one compact record:

- is conserved;
- transfers between objects;
- converts among several behavioral forms;
- constrains possible outcomes;
- predicts whether transformations can occur.

23. Entropy-Like Behavior and the Loss of Recoverable Distinction

Irreversibility may arise when multiple distinct earlier states lead to one later accessible state.

23.1 Branch Merging

Suppose histories H_1 and H_2 differ at an earlier stage but later produce states indistinguishable under every accessible probe.

If the difference cannot be reconstructed, accessible information has been lost.

23.2 Hidden Preservation

The distinction may still survive in latent structure or complete provenance.

An external genesis observer may retain reversibility while embedded observers experience irreversibility.

This distinction permits several levels of entropy-like behavior.

23.3 Dispersal

A localized signature may spread across many cubes until no small region contains enough information to reconstruct the original object.

The information may remain globally present but operationally inaccessible.

23.4 Coarse-Graining Through Wrapping

A wrapped observer may see only boundary summaries.

Different interiors may therefore appear identical.

Repeated wrapping can increase the number of hidden distinctions and generate effective irreversible dynamics.

23.5 Typical Evolution

Some state families may have many more accessible descendants than others.

World histories may therefore tend to move from rare highly constrained configurations toward larger families of operationally similar states.

A statistical arrow-like behavior could emerge without defining entropy numerically at the outset.

23.6 Memory and Erasure

An observer that overwrites a finite internal register merges previously distinguishable histories.

The physical cost or collateral changes associated with such erasure may later become a subject of recognition.

24. Geometry From Propagation

The primitive cube has an imposed combinatorial adjacency, but physical geometry should be inferred from how influences propagate.

24.1 Operational Distance

Two addresses are operationally separated by the smallest number of update stages required for one to influence the other under specified conditions.

This distance may differ from the visible number of intervening cubes if:

- some contacts block propagation;
- latent shortcuts exist;
- vacancies accelerate or delay transfer;
- wrapping creates new interfaces.

24.2 Dynamic Geometry

The propagation relationships may change over time.

A world can alter its own effective geometry by:

- creating or removing contacts;
- opening vacancy tunnels;
- forming wrapped shortcuts;
- changing local update delays;
- activating latent connections.

24.3 Curvature-Like Behavior

Suppose identical propagating patterns follow different paths or return times in different regions because local contact and update structure varies.

A recognition system may later describe this as curvature-like geometry.

The primitive ledger records only path deviation and clock comparison.

24.4 Geometry Generated by Matter-Like Structure

Persistent localized histories may alter nearby propagation relationships.

If other histories then follow changed routes, physical geometry is no longer a fixed background. It is dynamically coupled to occupancy and history.

24.5 Dimensional Emergence

The effective number of independent propagation directions may differ across regions and scales.

Some assemblies may behave line-like, sheet-like, volume-like, branching, or higher-connected despite being built from primitive cubes.

Dimension becomes an observed property of accessible motion rather than a fixed assumption inherited from the visual substrate.

25. Toward Relativity-Like Recognition

Relativity-like mathematics may become recognizable if the world generates finite propagation, internal clocks, and observer-dependent reconstruction.

25.1 Embedded Observers

An observer is a persistent assembly with:

- a localized history;
- a recurring internal process;
- a record store;
- local probes;
- the ability to send and receive disturbances.

25.2 Clock Comparison

Observers exchange propagating signals and compare internal cycles.

The comparison may depend on:

- relative propagation;
- field-like background;
- path history;
- local update structure.

25.3 No External Preferred Description

Although the genesis ledger may maintain a complete update record, embedded observers need not have access to that record.

Their physical descriptions should be constructed from internal measurements.

If no operational test identifies one observer description as privileged, a relativity-like principle may emerge.

25.4 Transformation Between Descriptions

A systematic rule may translate event addresses and clock records between observers.

The rule should be discovered from signal exchanges and shared events, not inserted from known spacetime equations.

25.5 Invariant Propagation

A particularly strong result would occur if all suitable observers infer the same maximum signal-propagation behavior despite differing accounts of distance and duration.

This could support a later recognition of relativistic kinematics.

25.6 Dynamic Clock Rates

Internal clocks may change rates when:

- observers propagate differently;
- they occupy different field-like regions;
- their internal binding changes;
- they follow different paths through dynamic geometry.

Consistent translation among such clock histories would be required before a relativity-like interpretation becomes credible.

26. Toward Quantum-Like Recognition

The system contains several ingredients that could eventually produce quantum-like behavior:

- persistent branching;
- latent intermediate states;

- observer-limited projections;
- phase-like cycles;
- interference-like combination;
- relational hidden structure;
- indistinguishable histories.

None of these alone establishes quantum physics.

26.1 Branching Histories

The same accessible state may permit several future continuations.

Branching may remain even when the complete manifest state is known.

The first question is whether the latent and provenance layers remove the branching.

If they do, the observer sees effective uncertainty generated by hidden context.

If they do not, the full system itself remains multiple.

26.2 History Combination

Two distinct construction histories may produce the same manifest outcome.

If later behavior depends on whether both histories remain available, the system contains more than ordinary probabilistic branching.

The histories may reinforce or cancel through latent phase relations.

26.3 Contextual Outcomes

A probe outcome may depend not only on the target cube but on the complete probe arrangement.

No context-independent mark need exist that predetermines every possible probe result.

This would create contextual measurement-like behavior.

26.4 Measurement as Interaction

An observer does not passively read a preexisting state.

Its probe interacts with the target and generates a joint history.

Different probes may expose different manifest projections of the same latent structure.

26.5 Entangled-Like Histories

Two separated objects may share a relational latent record created during an earlier local encounter.

Their later outcomes may remain correlated even when neither object carries a complete local representation of the relation.

Any influence must still respect the full system's propagation rules unless nonlocal updating independently emerges.

26.6 Complex-Like State Representation

The paired manifest-latent description generated by four-stage cycles may provide the operational ancestry of complex amplitudes.

The recognition becomes significant if this representation predicts:

- interference;
- phase-dependent outcomes;
- reversible evolution;
- probability-like manifest frequencies;
- transformations among observer contexts.

26.7 Probability From Manifest Projection

The full world may contain a richer latent history than an observer can access.

Observed frequencies may arise from projecting the full dynamics into manifest outcomes.

Alternatively, branching may be irreducible even in the complete ledger.

These two cases should not be conflated.

26.8 Recognition Standard

A quantum-like recognition would require an exact operational translation reproducing a substantial family of known quantum behaviors.

Visual resemblance, branching, or hidden states are insufficient.

27. The Four-Mode Physical Ontology

The evolving cube framework may be summarized through four primitive modes.

27.1 Being

Manifest occupancy provides directly readable structure.

27.2 Becoming

Ordered updates provide histories, events, persistence, and transformation.

27.3 Latency

Hidden operative structure provides intermediate phase, potential transformation, relational memory, and incomplete manifestation.

27.4 Absence

Missing occupancy provides deficit, vacancy motion, boundary, defect, obstruction, and global topology.

These modes are not independent substances. They may transform into one another.

A physical world arises from their lawful interconversion.

27.5 Why Four Modes May Be Sufficiently Fertile

Being alone gives static configuration.

Being and becoming give dynamics.

Latency adds hidden transformation structure and phase.

Absence adds defect, opposition, boundary, and topology.

Together, they support possible operational ancestors of:

- real and complex quantity;
- positive and negative structure;
- object and field;
- wave and particle;
- local and global organization;
- reversibility and irreversibility;
- geometry and topology;

- classical and quantum-like description.

This does not prove sufficiency for all physics.

It defines a compact ontology with unusually broad generative potential.

28. A Physical Genesis Ledger

The temporal system requires an expanded genesis ledger.

For every world update, it should record:

- manifest occupancy;
- manifest labels;
- latent records;
- vacancy and forbidden-address states;
- contact relations;
- active update rules;
- local event order;
- branch structure;
- propagation traces;
- observer records;
- conserved signature checks;
- complete lineage.

28.1 Event Provenance

Every event must identify the smallest recorded context sufficient to replay it.

If the context later proves insufficient, the event record is revised through an appended correction rather than silent replacement.

28.2 Object Lineage

Every persistent localized history receives a lineage record connecting all of its recognized stages.

If the lineage branches, each descendant retains the common ancestry.

28.3 Observer Ledger

Each embedded observer maintains its own partial record.

The external genesis ledger separately records:

- what the observer could access;
- what it stored;
- what it inferred;
- what the full world contained.

This allows direct study of effective physical law.

28.4 Recognition Quarantine

Terms such as particle, field, force, energy, spacetime, wavefunction, charge, and entropy remain excluded from the physical genesis ledger.

They enter only after the anonymous histories satisfy explicit operational translations.

29. Experimental Milestones

A practical research program should proceed through bounded milestones.

29.1 Temporal Persistence

Generate at least one nontrivial pattern that persists across many updates.

29.2 Local Propagation

Demonstrate a disturbance moving through successive neighboring cubes with a finite propagation bound.

29.3 Vacancy Dynamics

Generate a moving vacancy with a reproducible interaction signature.

29.4 Latent Cycle

Generate a four-stage manifest-latent cycle without encoding known complex arithmetic.

29.5 Wave-Like Interference

Generate two propagating periodic disturbances that reinforce and cancel predictably.

29.6 Localized Collision

Generate persistent localized histories with repeatable incoming and outgoing patterns.

29.7 Conserved Signature

Discover a nontrivial canonical record preserved across several interaction types.

29.8 Field-Like Mediation

Generate a distributed condition that affects local motion and is altered by the moving objects.

29.9 Internal Observer

Generate an assembly capable of clocking, recording, and comparing local events.

29.10 Effective Physical Recognition

Freeze the genesis ledger and test whether outside recognition systems identify coherent known physical mathematics.

Each milestone should be certified independently.

30. Preliminary Implications

The extension from static cubes to temporal, latent, and missing cubes changes the nature of the project.

The static system asks how mathematics may emerge from anonymous formal possibility.

The temporal system asks how physics may emerge when possibility acquires history.

The latent system asks how unseen but operationally necessary structure enters the description.

The missing system asks how absence can become an active carrier of law.

The resulting hypothesis is not that the universe is literally composed of labeled cubes.

It is that a finite substrate containing presence, change, latency, and absence may be sufficient to regenerate many structural necessities of physical theory.

The cube remains a seed, not a claim about ultimate material ontology.

Its value lies in making the full developmental process discrete, replayable, and open to retrospective recognition.

31. Computational Architecture for Physical Ontogenesis

The physical extension requires more than a larger static search. It requires an engine capable of preserving complete world histories while distinguishing manifest, latent, and missing structure.

A minimal architecture contains:

- a world-state registry;
- a local update engine;
- a propagation tracker;
- a vacancy and defect engine;
- a latent-state engine;
- a history and lineage ledger;
- an observer simulator;
- an invariant-discovery module;
- an external recognition system;
- an independent verifier.

Each module should operate through exact records rather than informal interpretation.

31.1 World-State Registry

The registry stores every certified world state.

A world state contains:

- all available addresses;
- manifest occupancy;
- the complete labeling of manifest cubes;
- latent records attached to sites, contacts, or assemblies;
- vacancies;
- forbidden addresses;
- contact relations;
- active rule identifiers;

- observer states;
- wrapping relationships;
- links to preceding and succeeding world states.

A world state is not identified solely by its visible arrangement. Two worlds with identical manifest projections remain distinct if their latent structures, vacancy histories, or provenance differ.

31.2 Local Update Engine

The update engine applies bounded transformation rules.

A rule may inspect:

- one cube;
- one contact interface;
- a bounded neighborhood;
- a short history segment;
- a latent record;
- a vacancy pattern.

It may then change:

- marks;
- orientation;
- occupancy;
- contact;
- latent structure;
- branch availability;
- wrapping state.

The engine should not contain named physical operations.

It should not directly implement acceleration, momentum, wave propagation, quantum measurement, or field equations. Those must emerge from repeated local update behavior.

31.3 Update Scheduling

The order in which local rules are applied may substantially affect the resulting world.

Several schedules should therefore be tested:

- simultaneous local update;
- sequential update;
- random but recorded update;
- event-triggered update;
- observer-relative update;
- partially ordered update.

A structure that appears only under one arbitrary scheduling convention may be less fundamental than one whose behavior persists across several schedules.

The schedule itself may eventually become generated rather than externally fixed.

31.4 Propagation Tracker

The propagation tracker compares paired histories differing by one initial event.

It records:

- the first address affected;
- the update stage at which each later address diverges;
- the maximum propagation radius;
- blocked and accelerated pathways;
- branch-sensitive influence;
- latent and vacancy-mediated propagation.

This module permits operational discovery of influence structure without assuming a prior geometry.

31.5 Vacancy and Defect Engine

The vacancy engine preserves absence as a positive record.

It tracks:

- vacancy creation;

- vacancy movement;
- vacancy merging;
- cavity formation;
- tunnel formation;
- boundary change;
- defect interaction;
- filling and erasure;
- historical residues after refilling.

A vacancy should never disappear from the ledger merely because it becomes occupied. Its history may remain relevant to later behavior.

31.6 Latent-State Engine

The latent engine stores structures that influence updates but are not accessible through ordinary manifest probes.

Latent records may be attached to:

- individual addresses;
- manifest cubes;
- contact interfaces;
- pairs of cubes;
- distributed assemblies;
- branches;
- transition intervals.

The engine should distinguish between:

- hidden manifest information;
- latent transformation capacity;
- relational latency;
- distributed latency;
- unmanifested branch potential.

These categories may later collapse or divide under operational testing.

31.7 History and Lineage Ledger

The history ledger links world states into replayable developmental paths.

It must retain:

- all branch points;
- all merged histories;
- all object lineages;
- all vacancy lineages;
- all latent conversions;
- all observer records;
- all compressed histories and their expansion procedures.

A physical claim unsupported by lineage cannot be certified.

31.8 Observer Simulator

An observer simulator should be constructed from the same cube substrate.

It receives only permitted local inputs and maintains a finite internal record.

The simulator may include:

- an internal cycle;
- an input interface;
- a memory assembly;
- a comparison procedure;
- an output record;
- a prediction procedure.

The external ledger records both the observer’s accessible world and the complete world.

This makes it possible to study the difference between fundamental and effective law.

31.9 Invariant-Discovery Module

The invariant module searches for canonical records that remain unchanged across classes of updates.

Candidate signatures may be generated from:

- mark counts;
- orientation classes;
- vacancy structure;
- latent-cycle patterns;
- boundary records;
- object lineage;
- interaction outcomes;
- history topology.

The module should not search only for numerical invariants. It should also seek symbolic, structural, and relational persistence.

31.10 Independent Recognition

Only frozen histories should be transferred to the recognition system.

The recognizer may compare anonymous structures with known:

- dynamical systems;
- algebraic structures;
- number systems;
- wave equations;
- defect models;
- field theories;
- relativistic models;
- statistical systems;
- quantum formalisms.

Recognition results should never alter the original anonymous lineage.

32. Reduced Experimental Worlds

The complete labeled-cube universe is far too large for direct temporal exploration.

The first physical experiments should use drastically reduced worlds while preserving the essential ontology.

32.1 Small Mark Alphabets

Begin with only a few anonymous marks.

The marks should not initially be interpreted as numbers, signs, colors, or truth values.

Even two or three marks can generate substantial local history when distributed across twenty-six sites.

32.2 Small Spatial Assemblies

Initial worlds may contain:

- one cube;
- two contacting cubes;
- a short line of cubes;
- a small sheet;
- a compact block;
- a ring-like contact assembly;
- a wrapped cluster.

The purpose is not visual realism. It is exhaustive analysis of histories.

32.3 Bounded Rule Grammar

The first temporal grammar may permit only:

- exact mark matching;
- copying;
- exchanging;
- one-step replacement;
- manifest-to-latent conversion;
- manifest-to-vacancy conversion;

- vacancy filling;
- nearest-neighbor contact update.

Every rule in the bounded grammar may then be exhaustively tested.

32.4 Complete History Trees

For sufficiently small worlds and shallow update depth, the complete branching history tree can be generated.

This allows exact measurement of:

- branching;
- merging;
- recurrence;
- persistence;
- propagation;
- loss of recoverable distinction;
- latent-state necessity;
- vacancy dynamics.

32.5 Progressive Enlargement

World complexity should increase one dimension at a time:

- larger mark alphabet;
- larger assembly;
- deeper history;
- wider local context;
- additional latent states;
- dynamic contact;
- recursive wrapping;
- observer insertion;
- rule-bearing cubes.

This stratification makes it possible to identify which primitive extension produced each new behavior.

33. Search Strategy

A raw search for known physical phenomena would violate the delayed-recognition principle.

The system must instead search for anonymously fertile histories.

33.1 Temporal Novelty

A history is novel when its operational signature differs from every stored history under the current probe family.

Novelty may involve:

- a new persistence pattern;
- a new propagation form;
- a new latent cycle;
- a new vacancy interaction;
- a new conserved signature;
- a new observer discrepancy.

33.2 Historical Compression

A history is compressible when a short generator reproduces a long sequence of world states.

Strong temporal compression may indicate law-like behavior.

33.3 Perturbation Stability

A structure should be tested after:

- one mark is changed;
- one cube is removed;
- one latent record is altered;
- one update is delayed;
- one contact is changed;
- one branch is replaced.

Some patterns will collapse immediately. Others will repair themselves or settle into related histories.

33.4 Generative Continuation

A fertile physical structure should create future possibilities.

A persistent localized history is more significant when it:

- generates descendants;
- binds with others;
- emits disturbances;
- modifies fields;
- creates or repairs vacancies;
- participates in conserved transfer.

33.5 Cross-World Recurrence

The same operational history may arise from different seeds or rules.

Repeated independent emergence strengthens the case that the structure is not an artifact of one arbitrary encoding.

33.6 Observer Robustness

A candidate physical law should be tested across several internally generated observers.

The law becomes stronger if different observers recover compatible descriptions through reproducible translations.

34. The Search for Complex-Like Structure

The proposed route from latent cycles to complex-number-like mathematics requires especially strict controls.

Otherwise, familiar complex arithmetic could be smuggled into the system through the rule design.

34.1 No Preassigned Quarter-Turn Rule

The search grammar should not contain an instruction equivalent to a quarter turn in an abstract plane.

It should contain only local transformations of marks, occupancy, and latency.

34.2 Independent Discovery of Four-Stage Cycles

The system should search all recurrent short cycles, not only cycles of length four.

A four-stage cycle becomes important only if it also displays:

- paired opposition;
- composition stability;
- preserved combined signature;
- applicability to many objects;
- predictive value in wave-like encounters.

34.3 Emergent Paired Coordinates

A paired description should be introduced only after it compresses the behavior of a broad generated family.

The pair should not be assumed to contain a real and an imaginary component.

It may later be recognized that way if the transformation rules justify the translation.

34.4 Multiplicative-Like Action

Complex-number-like recognition becomes stronger if latent-cycle structures can act on other generated states in a consistent compositional manner.

The action should support:

- repeated application;
- combination of transformations;
- identity-like behavior;
- opposition after two stages;
- restoration after four;
- distributed phase relations.

34.5 Physical Necessity

The strongest evidence would occur if a manifest-only description fails to predict interference-like histories, while the paired manifest-latent description succeeds.

Complex structure would then be operationally necessary rather than aesthetically convenient.

35. The Search for Signed Structure

Missing cubes provide a possible route toward negative-like quantities, but absence alone is insufficient.

35.1 Reference Dependence

A vacancy becomes deficit-like only relative to a recurrent reference structure.

The reference itself must be generated and stable.

35.2 Opposed Transformations

Addition and removal procedures should emerge as transformations that restore one another under specified conditions.

35.3 Canonical Residual

The system should reduce an assembly to a canonical residual after all permitted extra-vacancy cancellations.

Equivalent histories should produce the same residual.

35.4 Ordered Extension

Signed structure becomes richer when departures from a reference can be repeatedly combined, reversed, and compared.

35.5 Independence From Numerical Labels

No primitive cube mark should directly mean positive, negative, or zero.

Those meanings should arise from cancellation and reconstruction behavior.

36. The Search for Particle-Like Structure

The system should search for persistent localized histories without rewarding resemblance to known particles.

36.1 Localization Score

Measure how small a neighborhood is required to distinguish the history from the background.

36.2 Persistence Depth

Measure how many updates the signature survives.

36.3 Mobility Profile

Record possible displacement histories across backgrounds and field-like conditions.

36.4 Collision Signature

Record every stable outcome from encounters with other localized histories.

36.5 Internal Phase

Record recurrent internal cycles and their effects on collisions.

36.6 Defect Composition

Determine whether the localized history is primarily:

- an occupancy pattern;
- a vacancy pattern;
- a latent pattern;
- a mixed structure.

36.7 Species Recognition

Families should be defined operationally by signatures, not visual form.

Two different-looking structures may belong to one species-like family if they transform into one another and share interaction behavior. Two visually identical structures may belong to different families if their latent histories differ.

37. The Search for Field-Like Structure

A field-like structure must alter transitions across a distributed region.

37.1 Probe Particles

Standardized localized histories can be sent through different regions.

Differences in their propagation reveal distributed transition structure.

37.2 Source Removal

A candidate source should be removed to determine whether the distributed condition changes.

37.3 Delayed Response

If the field-like condition propagates locally, distant changes should occur after measurable update delay.

37.4 Back-Reaction

The probe should alter the field-like state if the coupling is genuinely dynamical.

37.5 Stored History

The field may retain evidence of prior sources or interactions.

37.6 Multiple Couplings

Different particle-like histories may respond differently to the same distributed condition.

This may reveal multiple field channels or species-specific interaction.

38. The Search for Spacetime-Like Structure

The cube lattice should not automatically be equated with physical space.

Physical geometry should be reconstructed from propagation and clock behavior.

38.1 Signal Geometry

Distances are inferred from minimum signal histories rather than cube coordinates alone.

38.2 Clock Geometry

Observers compare cycle counts along different histories.

38.3 Dynamic Contact Geometry

Contacts may appear, disappear, or become latent, changing effective adjacency.

38.4 Matter-Dependent Geometry

Persistent localized histories may alter local propagation and clock rates.

38.5 Observer Translation

Systematic translations among observer records may eventually support spacetime-like recognition.

38.6 Background Independence Test

A strong result would occur if effective geometry were determined primarily by generated relational structure rather than by the fixed visual placement of primitive cubes.

39. The Search for Quantum-Like Structure

Quantum-like recognition is particularly vulnerable to overinterpretation.

The system should satisfy a demanding sequence of tests.

39.1 Irreducible Contextuality

Outcome differences must persist after all accessible local hidden records are included, or the system must clearly identify the hidden level responsible.

39.2 History Interference

Distinct histories must combine in a way not reproducible by ordinary frequency mixing alone.

39.3 Latent Phase Dependence

Outcome probabilities or branch weights must depend on generated latent phase relations.

39.4 Reversible Hidden Evolution

The full latent-manifest state may evolve reversibly even when manifest observations appear probabilistic.

39.5 Measurement Disturbance

Different probes must produce different joint histories rather than merely reveal fixed hidden marks.

39.6 Relational Correlation

Separated objects may share a relational record not reducible to independent local manifest states.

39.7 No Superficial Naming

Branching, uncertainty, and hidden states alone do not justify a quantum label.

A substantial operational translation is required.

40. Major Failure Modes

The physical extension creates new opportunities for conceptual error.

40.1 Time Smuggling

A global external update counter may be mistaken for physical time.

Physical time must be recognized from internal process relations.

40.2 Space Smuggling

The visible cube arrangement may be mistaken for physical space.

Effective geometry must be inferred from operational propagation.

40.3 Particle Smuggling

A cube may be prematurely identified as a particle.

Particle-like identity should belong to a persistent localized history, not necessarily to one carrier cube.

40.4 Field Smuggling

A preassigned numerical value at every site may be called a field without generative justification.

A field-like object should alter local transition possibilities and participate dynamically.

40.5 Complex-Number Smuggling

A latent cube may be directly assigned the imaginary unit.

This would defeat the experiment.

Complex-like structure must arise from independently generated transformation cycles and paired behavior.

40.6 Negative-Number Smuggling

A missing cube may be declared negative one.

Absence becomes negative-like only through reference, opposition, cancellation, and stable combination.

40.7 Quantum Smuggling

Any branching or contextual behavior may be described as quantum.

Such language should be withheld until a rigorous translation supports it.

40.8 Relativity Smuggling

Finite propagation alone does not generate relativity.

The system must also develop internal clocks, observer translations, and invariant operational relations.

40.9 Conservation by Design

If update rules explicitly preserve a hand-selected numerical total, the discovered conservation law is trivial.

More significant invariants should be found through analysis of anonymously generated histories.

40.10 Hidden Global Control

A supposedly local world may secretly depend on a global scheduler or evaluator.

All such dependencies must be declared.

41. Falsifiability

The principal claims of physical ontogenesis should be vulnerable to failure.

41.1 Failure of Physical Emergence

The system may generate temporal complexity but no stable physical organization.

Histories may remain:

- short-lived;
- nonlocal;
- incompressible;
- observer-dependent without translation;
- devoid of conserved signatures;
- incapable of persistent interaction.

In that case, ordered cube change would not have produced physics.

41.2 Failure of Latent Necessity

Every latent behavior may turn out to be reproducible through a larger manifest description.

Latent cubes would then be useful compression devices but not a distinct operational mode.

41.3 Failure of Complex-Like Emergence

Four-stage cycles may occur but fail to support a broad compositional structure or predictive paired description.

They would remain cycles rather than complex-number-like mathematics.

41.4 Failure of Missing-Cube Fertility

Vacancies may generate only ordinary boundary effects without signed, particle-like, or topological structure.

41.5 Failure of Observer Physics

Generated observers may fail to recover stable effective laws.

Their records may remain too incomplete or idiosyncratic for systematic translation.

41.6 Failure of Novelty

The system may reproduce only familiar discrete models already implicit in the local rule grammar.

41.7 Failure Through Excess Flexibility

If arbitrary latent states and missing structures can be invoked to explain every anomaly, the framework becomes unfalsifiable.

Latent and missing records must therefore be generated by explicit rules and independently verified.

42. Principal Conjectures

The framework supports several testable conjectures.

42.1 Temporal Ontogenesis Conjecture

Anonymous local updates of finite marked cells can generate persistent histories later recognizable as dynamical physical objects.

42.2 Propagation Geometry Conjecture

Effective geometry will emerge from influence propagation and internal clock comparison rather than merely reflect the fixed cube arrangement.

42.3 Latent Completion Conjecture

Some manifest histories will admit compact deterministic or reversible descriptions only after latent structures are included.

42.4 Complex Phase Conjecture

A family of generated latent cycles will support a paired compositional structure later recognizable as complex-number-like mathematics.

42.5 Structured Absence Conjecture

Vacancies will generate stable deficit, cancellation, defect, boundary, and topology-like behavior not reproducible by blank manifest labels alone.

42.6 Defect Particle Conjecture

Some missing-cube patterns will propagate and interact as persistent localized histories.

42.7 Wave–Particle Ancestry Conjecture

Distributed and localized histories will arise as different stable regimes of common underlying update processes.

42.8 Conservation Completion Conjecture

Apparent losses in the manifest layer will often be restored as conserved signatures when latent and missing structure are included.

42.9 Effective Observer Conjecture

Embedded observers with limited access will derive stable laws that differ from, but are systematically related to, the complete genesis dynamics.

42.10 Relativity-Like Conjecture

Finite propagation and internal clock exchange will generate observer translations with invariant operational structure.

42.11 Quantum-Like Conjecture

Persistent branching, latent phase, history combination, and contextual measurement will jointly generate a structure requiring more than classical manifest-state description.

42.12 Physical Surplus Conjecture

Generated worlds recognized through known physical mathematics will retain operational behavior not captured by the familiar theory.

43. Criteria for Genuine Physical Emergence

A generated structure should not be called physical merely because it moves or persists.

A strong claim requires several conditions.

43.1 Anonymous Origin

The behavior must arise without its known physical equations being built into the rule grammar.

43.2 Local Generative History

Every event must possess a replayable local lineage.

43.3 Persistent Identity

The candidate object must survive across changes under a stable operational signature.

43.4 Interaction

It must produce reproducible changes in other generated histories.

43.5 Propagation Constraint

Its influence must follow discoverable reachability rules.

43.6 Invariance

Some nontrivial signature should persist through significant interactions.

43.7 Observer Reconstruction

Embedded observers should be able to form partial but systematic records.

43.8 Mathematical Translation

The generated behavior should admit explicit comparison with known physical mathematics.

43.9 Adversarial Testing

Competing explanations and counterhistories must be explored.

43.10 Generative Surplus

Unexplained behavior should remain preserved rather than removed to improve the fit.

44. Four Modes and the Expansion of Mathematics

The four primitive modes may generate more than physics.

44.1 Being and Static Mathematics

Manifest configurations support finite arrangement, incidence, classification, and transformation.

44.2 Becoming and Dynamical Mathematics

Ordered change supports recurrence, process, computation, flow, and history.

44.3 Latency and Extension Mathematics

Latent structures support hidden state, phase, transformation capacity, paired descriptions, and completion of manifest systems.

44.4 Absence and Defect Mathematics

Missing structures support zero-like balance, negative-like deficit, topology, obstruction, complement, boundary, and defect propagation.

44.5 Combined Modes

The most fertile structures may require all four.

For example:

- a manifest localized history may propagate through vacancies;
- its internal phase may remain latent;
- its motion may alter a field-like background;
- its collision may conserve a combined manifest-latent-defect signature.

The resulting mathematics may not divide cleanly into conventional subjects.

45. Metaphysical Interpretation

The genesis ledger should remain free of metaphysical declarations, but the completed framework invites philosophical reflection.

45.1 Being

Manifest occupancy represents what is presently disclosed.

45.2 Becoming

History represents the ordered transformation through which identity persists.

45.3 Latency

Latent structure represents what is operative without being fully manifest.

45.4 Absence

Missing structure represents what influences the world by not being present.

45.5 Relation Before Substance

The system suggests that physical identity may belong less to isolated cubes than to persistent relations across histories.

A particle-like object may be a stable lineage.

A field-like object may be a distributed rule condition.

A vacancy may behave as an entity without being a substance.

A latent phase may be physically necessary without being directly visible.

45.6 Logos and Generative Order

If broad mathematics and physics emerge from stable relations among being, becoming, latency, and absence, their unity would precede their familiar names.

Such unity may be interpreted metaphysically as an expression of Logos: an order in which possibility, transformation, concealment, and absence participate in one generative coherence.

That interpretation must remain posterior to operational demonstration.

The system should first show that the structures share a real generative ancestry.

46. A Minimal Demonstration Program

A first implementation should aim at one complete developmental chain rather than the whole of physics.

A suitable target would be:

1. construct a small finite cube assembly;
2. define a bounded anonymous update grammar;
3. generate a persistent background;
4. create one vacancy;
5. demonstrate vacancy propagation;
6. generate one localized manifest disturbance;
7. demonstrate interaction between the disturbance and vacancy;
8. discover one preserved signature;
9. generate one latent intermediate cycle;
10. show that the latent description predicts an outcome missed by the manifest description;
11. insert a simple observer assembly;
12. compare observer records with the full ledger;
13. freeze the anonymous history;
14. attempt external mathematical and physical recognition.

This experiment would not reproduce modern physics.

It would test whether the conceptual ladder is operationally coherent.

47. Discussion

The transition from static labeled cubes to evolving cube worlds is not a small extension.

The static system concerns possible structures.

The temporal system concerns lawful histories.

The addition of latent cubes and missing cubes further changes the ontology. A world is no longer composed only of what is visibly present. Its future may depend on hidden transformation capacity and on structured patterns of absence.

This richer ontology is motivated by two observations.

First, many important mathematical structures arise when an original domain is extended. Signed quantities extend counting through opposition and cancellation. Complex quantities extend manifest magnitude through phase-like transformation. Topological structures often depend on holes and absences rather than material occupancy.

Second, physical theories repeatedly employ entities that are not adequately described as directly visible material objects. They use fields, phases, potentials, vacancies, defects, virtual intermediates, state spaces, and unobserved histories.

The present framework does not import those concepts. It asks whether their operational ancestors can arise from a simpler anonymous substrate.

The magic cube is therefore not supernatural.

It represents structure that acts without appearing in the ordinary manifest description.

The missing cube is not merely an empty cube.

It represents an addressable absence whose creation, motion, and interaction affect future histories.

The time-dependent cube is not merely a cube whose labels are functions of an external variable.

It is a history-bearing process whose identity may migrate across many material carriers.

Together, these ideas produce a substrate in which objects, waves, particles, fields, geometry, and observers may arise as different forms of organized history.

The proposal also changes the interpretation of complex and negative quantities.

A negative-like object may originate in deficit relative to a generated template.

An imaginary-like object may originate in a latent transformation phase required to complete a recurrent cycle.

These structures would then be neither arbitrary inventions nor primitive metaphysical entities. They would be recognized compressions of operational relationships generated within the system.

The distinction between the full genesis world and the observer's manifest projection is equally important.

An observer may experience branching because latent distinctions are inaccessible. It may observe apparent nonconservation because signatures have moved into vacancy or latent structure. It may infer nonlocal relations because a distributed relational history is not locally readable. It may require complex-valued mathematics because manifest states omit intermediate phase.

Effective physical theory may therefore emerge as the best compression available to a restricted observer.

The complete genesis ledger supplies a deeper description, but it need not resemble the observer's theory.

This architecture creates a controlled way to study how physical formalism may depend on access, scale, and ontology.

48. Conclusion

This paper has proposed an extension of anonymous cube-based mathematical generation into a framework for physical ontogenesis.

The starting point is a temporally ordered world of marked cubic cells.

Each complete world state records:

- manifest cubes;
- latent cubes;
- vacancies and forbidden addresses;
- contacts;
- local update rules;
- branch structure;
- construction history;
- observer records.

The system begins with no named physical concepts.

It permits local change and preserves complete histories.

Physics becomes recognizable only if the generated world develops:

- finite propagation;
- persistent localized and distributed histories;
- interaction;
- conserved signatures;
- internal clocks;
- observer-relative records;
- stable translations among descriptions.

Latent cubes provide hidden operative structure. They may occupy transition intervals, relational records, distributed phases, or concealed layers. Recurrent latent cycles may generate paired transformation systems later recognizable as complex-number-like mathematics.

Missing cubes provide structured absence. They may behave as deficits, moving vacancies, defects, boundaries, tunnels, obstructions, and persistent topological features. Their opposition to additional occupancy may generate signed and zero-like structures through cancellation rather than definition.

The framework therefore combines four modes:

being, becoming, latency, and absence.

Being provides manifest form.

Becoming provides history.

Latency provides unmanifest transformation capacity.

Absence provides active deficit and boundary.

The central methodological rule remains:

Generate first, recognize second, and name last.

No generated history should be called a particle, field, force, energy, complex amplitude, spacetime, or quantum state until a precise operational translation justifies the name.

The system does not claim that the physical universe is literally made of cubes.

The cube is an experimental seed: finite enough to encode, rich enough to support incidence and contact, and recursive enough to generate new levels.

The deepest hypothesis is that physics may emerge when anonymous formal possibility acquires lawful history.

The static cube asks what may exist.

The temporal cube asks what may persist through change.

The latent cube asks what may act without being manifest.

The missing cube asks how absence may become structurally real.

A world in which these four modes interact may be capable of generating not only mathematics, but the first recognizable forms of physical law.

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