**Absolute Relativity / Overall V2 Theory – v0.9**  
Document: (5) V2 – Present-Act Engine  
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Project tokens: **“Absolute Relativity (AR)”** – ETH contract 0xAacCd7bA616405C184335F193fEf080fC982921F, SOL mint ARafKuCqRgszXZWjYGWyBT7GnLZkyiaXQd1YjXC1x224  
Project wallets (on-chain records): ETH 0x1F06ea3554aE665e713a637eD136a5065C9cD787, SOL 7mik22AsVKX2ueqSWHCD8HBMpcfEMhbKUb85xYoaxCKN  
For full project, token, and on-chain record details, see **(0) Front Matter & File Map.docx, §0.4**.

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**Preface: Notation Alignment for the Unified Framework**

Status: Updated for Semantic Consistency with Volume I (Formal Algebra).

Purpose: To resolve symbol collisions between the Present-Act Engine implementation (V2) and the Core Operator Algebra (Vol I).

In the Unified Absolute Relativity (AR) Framework, specific letters ($F$, $T$, $P$) are reserved for the fundamental operators of the theory (Renew, Trade, and Present Plane). To ensure mathematical precision and prevent ambiguity when merging the **Engineering Layer (V2)** with the **Theoretical Layer (Vol I)**, this document employs a unique, collision-free notation set for implementation variables.

The following standardizations have been applied throughout this text:

| **Concept** | **Old Notation (V2 Original)** | **New Unique Notation** | **Logic / Mnemonic** |
| --- | --- | --- | --- |
| **Finite Feature Alphabet** | $F$ | **$\Xi$** (Capital Xi) | Represents the discrete "stack" or "shelves" of finite features. Avoids conflict with the **Renew Operator ($F$)**. |
| **Inner/Qualia Selector** | $P$ | **$\Psi$** (Capital Psi) | Represents the Inner/Psychic selection relation. Distinct from the wavefunction (which is denied here) and avoids conflict with the **Present Plane ($\mathcal{P}$)**. |
| **Temporal Pixel** | $T^\*$ | **$\eth$** (Eth) | Represents a discrete, finite "step" or quanta of time (~0.1s). Avoids conflict with the **Trade Operator ($T$)**. |

All mathematical logic, budget constraints, and engine mechanics remain unchanged; these updates are purely notational to ensure rigorous compatibility across the full framework.

**Part I – Ontological Core: Presents, Contexts, and Spatial Hierarchy**

**1.1 Primitive: a present, not a thing**

**1.1.1 What a “present” is in this theory**

In this framework, the fundamental unit of reality is not an object, a field, or a state of matter—it is a **present**. A present is one indivisible experience of time taken as a whole: a “now” that cannot be split into smaller experiential pieces without ceasing to be the same now. It is not a time-slice of an external world; it is the basic *given* from which any notion of “world” is later reconstructed.

Each present has two intrinsic aspects:

* **Inward depth**: everything it already *contains* as its past.  
  The past is not somewhere “behind” it, but is folded into the present as retained structure. When we say a present has a past, we mean that certain patterns of relation are already stabilized inside it, giving it content and memory.
* **Outward standing**: the way this present stands among other presents that can “look back” to it.  
  These outward relations define its possible futures—how it can be taken up, continued, or extended by subsequent presents. The present itself does not yet know which continuation will occur; it simply stands in a web of possible relations.

There is no hidden substrate beneath these presents. We do not assume a pre-existing spacetime, material field, or abstract state space that then “carries” experiences. Instead, **presents plus their relations are the whole ontology**. Anything we later call “space,” “objects,” “world,” or “laws of physics” will be a particular way of organizing and reading the relations among presents, rather than a more fundamental layer beneath them.

This is what is meant by saying the theory is **present-first** and **qualia-first**: what exists, at the ground level, is the qualitative character of experience—this present—and the logical structure of how such presents can stand in relation to one another.

**1.1.2 Difference from the usual physics picture**

In standard physics, the primitive is typically something like:

* a state of a system at time (t),
* defined on a manifold (a spacetime continuum),
* evolving according to differential equations.

Experience—consciousness, the felt “now”—is then treated as a secondary or emergent phenomenon. The universe is thought to exist just as a four-dimensional block (or as dynamical fields), and our sense of presentness is something that appears *inside* that block as a byproduct of physical processes.

Here, the order of explanation is reversed:

* **Primitive**: a present experience-of-time.
* **Derived**: any notion of “state of the world at time (t)” is a ranking or description of how that present relates to other presents (inward and outward), as we reconstruct it from our vantage.

We are not taking a pre-given spacetime and then trying to fit experiences into it. Instead, we start with experience itself as the ontological primitive and show how a spacetime-like structure naturally emerges as a way of organizing nested presents. From this point of view, a “world state at (t)” is a convenient abstraction; what is actually real is the present that judges other presents as “earlier,” “later,” or “elsewhere” in relation to itself.

This shift is crucial: it removes the need to imagine an objective, observer-independent time that flows, and instead lets the felt structure of time (presents, sequencing, retention, anticipation) be the base from which any physical description must be built.

**1.1.3 Why this solves the “present moment” problem**

The “present moment problem” in standard physics arises because the dominant picture is a **block universe**: past, present, and future all coexist equally in a four-dimensional spacetime manifold. Within that picture, the present has no special ontological status; it is just one slice through the block among infinitely many. Yet phenomenologically, we experience a moving “now” that feels unique and central, and we experience a definite direction to time (past versus future).

In the present-first framework:

* **Only presents are ontically real.**  
  There is no fully existing “past” or “future” independently of what is retained in the present or what is being selected as a future continuation. Past and future are relational roles, not separate ontological regions.
* **The past** is precisely what is *retained inward* in the present.  
  When you remember something, or when a structure in your body or world is stable, that is the present containing its past. The past is not a detached region you could travel back to; it is the content and order already folded into now.
* **The future** is what is *co-eligible outward*.  
  Many possible next presents are compatible with the current one; these alternatives are the future. They are not yet realized, but they stand as possible relations the present could have to later presents.
* The **arrow of time** appears because inward retention and outward branching do not play symmetric roles: the present *fixes* one past but still participates in many possible futures. That asymmetry of retention vs branching is built into what a present is; we do not need to impose it later.

Because the present is ontologically primary, the “flow of time” no longer needs to be bolted onto a static block. The present *is* the locus of flow: a sequence of presents, each with its own retained past and branching futures, is precisely what we mean by time evolving. The uncomfortable need to explain “why we seem to move through a block” disappears; instead, the block is never assumed in the first place.

**1.1.4 Ticks and sequencing (just enough for now)**

To move from a single present to a structured time, we introduce the notion of a **tick**.

* A **tick** is the minimal transition from one present to the next in the history of a given center (what we will later call a 0-context). It is the smallest discrete “step of becoming” by which one present gives way to another.
* A **history** for a given 0-context is then a **sequence of presents connected by ticks**:  
  [  
  \dots \rightarrow \text{Present}*{k-1} \rightarrow \text{Present}*{k} \rightarrow \text{Present}\_{k+1} \rightarrow \dots  
  ]  
  Each arrow is a tick. The entire thread of such transitions is what, from within that context, feels like “my personal time.”

We will later describe ticks more formally using an operator algebra (Renew, Sink, Trade, Sync, etc.), but at this stage we only need three properties:

* **Discreteness** – Updates happen in steps, not in a continuous smear. Each tick is a definite transition from one present to another.
* **Locality** – A tick only relates a present to its immediate successor (and predecessor); there is no jumping over intermediate presents. This will be crucial when we derive causal structure and “no-skip” constraints in the engine.
* **Sequencing** – For each center, these ticks can be ordered into a linear history. That ordinal structure (which present comes after which) is what we later read as a personal timeline.

With these ingredients, we have the minimal structure needed to talk about **time as an ordered series of presents**, without invoking any background spacetime. The rest of the theory will show how, from this bare idea of “presents and ticks,” we can reconstruct the familiar notions of space, spacetime, motion, and physical laws.

**1.2 Nested contexts (−2, −1, 0, +1, +2, +3)**

**1.2.1 Context levels as roles, not layers**

Once we take the present as primitive, the next question is: *relative to what* is a present “inside” or “outside” anything? The answer in this framework is the idea of **context levels**. These are not fixed layers of stuff stacked in the universe; they are **roles** that different presents play relative to a chosen center.

We always choose a vantage—a present we call **0**—and then describe everything else in relation to it:

* **0**: the present we are centering (our “here/now” for the purposes of the theory).
* **Negative levels (−1, −2, …)**: contexts that 0 treats as *inside* itself, the structure it is made of.
* **Positive levels (+1, +2, …)**: contexts that 0 treats as *outside*, the environments and containers it is in.

A crucial point is that these indices (−2, −1, 0, +1, +2, +3) are **not absolute layers of reality**. They simply label how a given context is being read from a particular vantage. If we recenter on a different present, the same system can be re-labelled: what was +1 from one vantage might be 0 from another; what was −1 may become 0 when you zoom in.

So:

* “Level −1” means: *one step inward* from the current 0.
* “Level −2” means: *two steps inward*, and so on.
* “Level +1” means: *one step outward* from the current 0 (its immediate environment).
* “Level +2” means: *the environment of that environment*, and so on.

This will let us talk about “nested contexts” without implying rigid metaphysical strata. Everything is relational: context levels are positions in a web, defined by how a chosen 0 interprets other presents as inner, outer, or peer.

**1.2.2 How “inside/outside” and “bigger/smaller” map to these roles**

With context levels in hand, we can now make precise what we usually mean by “inside” and “outside,” or “smaller” and “larger,” from the standpoint of a particular 0.

From the perspective of a chosen 0:

* **“Inside me / smaller than me”**  
  refers to contexts at negative levels:
  + −1: immediate inner structure (for us: cells, tissue units, sub-organism chunks).
  + −2: deeper inner structure (for us: biomolecules, nanostructures, quantum degrees of freedom).  
    These are the presents 0 uses as *its own building blocks*.
* **“Peers like me”**  
  are other presents at the same level 0 within the same environment:
  + other organisms in the same world,
  + other 0-contexts that the +1 environment coordinates side-by-side.
* **“Environment I’m in”**  
  refers to contexts at positive levels:
  + +1: immediate environment of 0 (for us: the Earth-surface life-world we inhabit).
  + +2: environment of that environment (for us: the galactic disk that hosts Earth and similar worlds).
  + +3: broader cosmic shell/horizon that contains the galaxy.

So when we say:

* “X is *inside* Y,” we are asserting that, from Y’s vantage, X lives at a **negative context level** (−1, −2, …) relative to Y.
* “Y is *bigger than* X,” we are really saying that Y is being treated as a **higher context** that can contain X.

This is a relational re-reading of everyday spatial language. “Inside” and “outside” are no longer mysterious spatial relations; they are simply shorthand for “plays a more negative context role relative to the chosen 0” versus “plays a more positive context role.”

**1.2.3 The specific ladder for our vantage (−2, −1, 0, +1, +2, +3)**

For the rest of this work, we will fix a specific vantage:

* **0** = our **organism-centred present** (human or similar CNS-bearing organism),
* **+1** = the **Earth-surface** context in which those organisms live and interact.

From that fixed choice, the context ladder looks like this:

* **−2**:  
  Deep inner seam: nano/biomolecular/quantum scale.  
  For us: DNA, proteins, small molecules, nanostructures—features that are two steps “inside” our organism-level present.
* **−1**:  
  Cellular/micron scale.  
  For us: individual cells, small multicellular units, micro-tissues—the immediate building blocks that compose the organism.
* **0**:  
  Organism scale, as-one-with-parts.  
  For us: the whole multicellular organism that has a nervous system, body, and can host a stream of experiences (present-acts).
* **+1**:  
  Earth-surface environment.  
  For us: the shared world of landscapes, air, oceans, other organisms, social and ecological structures.
* **+2**:  
  Galactic disk.  
  For us: the Milky Way (or similar galaxies), which acts as the container for Earth-surface contexts.
* **+3**:  
  Cosmic shell / horizon.  
  For us: large-scale cosmic structures (supercluster sheets, CMB shell) that define the outermost environment we can currently access.

This ladder is how our 0-context (the organism) relates inward and outward. It is not the only possible ladder in principle, but it is the one that corresponds to *our* situation on Earth. Later, we will show that each of these bands has distinctive empirical signatures (fractals, GM pivots, morphologies), but at the ontological level they are first and foremost **roles that other presents play relative to us**.

**1.2.4 Why these are roles, not fixed tiers of “reality”**

It is tempting to hear “−2, −1, 0, +1, +2, +3” as rigid levels: as if reality were made of six stacked layers of stuff. That is not what this theory claims.

Key points:

* The same structure can appear at different levels depending on where you stand:
  + If we re-centred on a cell as 0:
    - its molecules would become −1,
    - its surrounding tissue might become +1,
    - the organism we call 0 would become +2 from that cell’s vantage.
* The numerical label is not “what something is”; it is “how we are reading it from this hinge.”
* The ladder we fix here is explicitly:
  + anchored at 0 = “our organism present,”
  + +1 = “our Earth-surface context.”

In other words:

* Context levels are **relational roles** in a nested structure of presents.
* For our purposes, we have fixed one particular hinge (our own) and named the roles we see around us as −2, −1, 0, +1, +2, +3.
* If a different kind of being, in a very different environment, did this construction, they would get their own 0 and their own ladder indexing.

This emphasis prevents us from reifying context levels as metaphysical castes. Everything in the theory is ultimately made of presents interrelating. Context indices are a convenient, but fundamentally relational, way of saying **who is treating whom as inside, who is acting as environment, and who is at the centre of experience for this discussion.**

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**1.3 Space as context hierarchy**

**1.3.1 Everyday spatial language as context talk**

We usually talk about space as if it were a neutral background, a container in which things sit. We say that one thing is “inside” another, that something else is “bigger,” or that two things are “next to” each other. In this framework, those expressions are not primitive facts about a pre-given geometry—they are ways of describing **how contexts are nested relative to a chosen 0**.

From the standpoint of our organism-level present (0):

* When we say something is **inside us** (our organs, cells, molecules), we are pointing at:
  + contexts at **−1, −2** (our inner levels),
  + the presents that we treat as what we *are made of*.
* When we say something is **around us** (air, room, city, Earth), we are pointing at:
  + contexts at **+1, +2, +3**,
  + the presents that function as our **environment**.
* When we say something is **beside us** (other people, animals, objects in the room), we are pointing at:
  + other 0-like contexts,
  + peers that share our +1 environment but are not inside us.

So, in this theory:

* “Inside/outside” = statements about **context role** (negative vs positive relative to 0).
* “Smaller/bigger” = statements about how far **inward or outward** a context sits in the ladder.
* “Alongside” = statements about being at the **same level** (peer 0s inside the same +1).

Space, at this level, is the **felt pattern** of these relationships: a way our 0-context describes which other presents it takes as components, which as peers, and which as environments or containers.

**1.3.2 Nested “spaces” are nested contexts**

A classic example of spatial hierarchy is the phrase:

“a molecule in a cell in a tissue in an organism in a room on Earth in a galaxy in a universe.”

In the context-ladder language, this is literally:

* molecule → **−2**
* in a cell → **−1**
* in a tissue → boundary zone between −1 and 0
* in an organism → **0**
* in a room / environment → **+1**
* on Earth → still +1 (larger region within the same band)
* in a galaxy → **+2**
* in a universe / cosmic shell → **+3**

What looks like a chain of nested spatial containers is exactly the chain of **context roles**:

* deeper inner presents (−2, −1) that 0 treats as its building blocks,
* 0 itself, the organism-level present,
* outward presents (+1, +2, +3) that 0 treats as its environment and containers.

There is no independent “space” in which this nesting happens. The nesting *is* space, from our vantage: it is how the relational structure of presents at different roles appears when you stand at 0 and ask “what is this in?” and “what is this made of?”

**1.3.3 Why this matters for the rest of the theory**

Seeing space as context hierarchy has three important consequences for everything that follows:

* **Space is not a neutral stage.**  
  Once we recognize that inside/outside/bigger/smaller are just shorthand for context relations, we no longer have to imagine a separate geometric arena where everything “sits.” The arena is the pattern of context roles themselves.
* **The context ladder directly shapes spatial experience.**  
  Because the ladder (−2, −1, 0, +1, +2, +3) around our organism-level present is empirically structured (with real scale bands and seams), our experienced “sizes” and “levels” are not arbitrary. The bands we later identify—nanoband, micron band, UGM band, kilometre band, kpc band, Gpc band—are the concrete ways this context hierarchy shows up as space.
* **Any future physics must respect the ladder.**  
  When we talk about motion, causality, or geometry later, we always mean:
  + motion = changes in how 0 relates to its inner and outer contexts,
  + causality = constraints on how those relations can be updated (ticks),
  + geometry = statistical regularities in those updates across the ladder.

By anchoring space to context roles from the beginning, we ensure that the later constructions—spacetime, gravity, quantum behaviour, and sensory experience—are all derived from a single, coherent picture: **nested presents, viewed from our hinge, appearing as nested “spaces” in our experience.**

**1.4 Why anything looks like “matter in space”**

**1.4.1 The +1-biased picture**

In everyday thinking, we treat the world as a collection of objects moving in space. There are tables, chairs, trees, planets—things with shapes and positions—and we seem to inhabit a 3D arena that contains them. In this theory, that view is recognized as a **+1-biased picture**: it is what we get when we let the +1 context (Earth-surface life-world) dominate our description and treat 0-contexts (organisms, bodies) simply as **parts inside that +1 environment**.

From our organism-level vantage:

* We take +1 as “the world” or “the environment.”
* We assign each 0-context (each organism, object, tool) a location and shape within +1.
* We then talk as if:
  + there is a fixed space (the +1 surface and its near extension),
  + and all 0-contexts are objects **in** that space.

This is a shorthand. What is really happening is:

* +1 is a **present context** that relates many 0-presents together at once.
* When we speak in object-and-space language, we are really talking about:
  + 0-contexts = centres of present experience that **we treat as parts**, and
  + +1 = the **pattern of relations** among those centres, rephrased as a spatial scene.

So “matter in space” is a way of talking about **presents and their relations** from the standpoint of +1, not a fundamental description of reality.

**1.4.2 From nested presents to “objects”**

An “object” in this framework is not a basic building block. It is:

A cluster of nested presents (at −2/−1/0 levels) that, from the +1 perspective, behaves as one coherent part.

For example, consider a rock:

* At −2 and −1:
  + it is a mass of grains, crystals, molecules, each with their own inner dynamics.
* At 0:
  + for most 0-contexts (organisms), the rock does not host its own present-acts; it functions as a **chunk of environment**, not as a centre of experience.
* At +1:
  + the rock is a **single part** of the Earth-surface world: it has a location, a shape, a certain set of relations (supports, blocks, collides with other parts).

The same logic applies to a chair, a car, a tree, or another person’s body. In each case:

1. inward structure (−2/−1) is rich and complex,
2. but at +1 the whole bundle is treated as a **single part**,
3. whose relationships to other parts (distances, forces, constraints) form what we naively call “physics of objects.”

Thus, **objects** are not fundamental—they are **coherent patterns of present-acts and context relations** that +1 renders as single units.

**1.4.3 Why “space full of objects” feels stable**

Despite this being a relational construction, our experience of “space full of objects” is very stable. The reasons are:

* **The context ladder is stable.**  
  The bands −2, −1, 0, +1, +2, +3 around our hinge do not fluctuate wildly. Rocks do not spontaneously become galaxies; cells do not suddenly behave as planets. The scales associated with “what counts as a part” are anchored by physical, biological, and cosmological regularities (UGM, Earth scale, galactic scale, etc.).
* **The present-act engine is stable.**  
  The rules by which contexts update (the V2 engine) are fixed:
  + same locality rules,
  + same typed budgets,
  + same gate structure,
  + same way of reconciling candidates and selecting acts.  
    This means that the way +1 “renders” 0-contexts as parts is consistent across time.
* **+1 as Collective Sphere coordinates many 0s.**  
  The Earth-surface environment (air, land, oceans, biosphere) acts like a **Collective Sphere**:
  + it synchronizes many 0-contexts,
  + ensures that they see broadly compatible patterns (same mountains, buildings, other people),
  + supports global regularities (day/night cycles, gravity, weather patterns).  
    Because all 0s are being coordinated by the same +1, they agree, to a high degree, on what the “world of objects” looks like.

When you combine:

* a stable ladder of contexts (so that parts, organisms, environments, and containers stay in their usual roles),
* a stable present-act engine (so that updates are coherent),
* and a stable +1 Collective Sphere (so that many 0-contexts are coordinated),

you get the phenomenology of a **robust, shared “space of objects.”**

What we feel as solid matter “out there,” arranged in space, is the persistent appearance of:

* 0-contexts and sub-contexts (−2/−1) treated as parts,
* their relations encoded in the +1 context,
* and our own present reading those relations from the 0↔+1 hinge.

In short:

* **Matter** = recurring patterns of nested presents that behave as coherent parts relative to +1.
* **Space** = the way +1 arranges and relates those parts when viewed from 0.

The **stability** of matter in space comes from the stability of the context roles and the engine, not from an independent substance or container behind them.

**1.5 L1 / L2 / L3 roles**

**1.5.1 Why we need these roles**

So far we have described:

* **What** exists: presents.
* **Where** they stand relative to a chosen 0: context levels (−2, −1, 0, +1, +2, +3).
* **How** they feel spatially: as a context hierarchy.

To describe *what these presents are doing* in time, we need a second set of labels: **L1, L2, L3**. These are not additional levels of reality; they are **process roles** that a given present can play in the dynamics of becoming:

* L1: “many possible futures” role.
* L2: “environment of possibilities” role.
* L3: “chooser / unifier” role.

Any given present can play different roles (L1, L2, L3) in different relational diagrams. The roles tell us how a present participates in:

* branching alternatives,
* their organization into consistent “worlds,”
* and the selection of one realized continuation.

**1.5.2 L1 — branching futures / timeline role**

L1 is the role that captures the **branching of possibilities**.

Given a present at 0 (your current now), there are many ways it can be continued. In the V2 engine language, there are many candidate next acts that:

* respect inward retention,
* satisfy local feasibility,
* and are, at least initially, co-eligible.

We call the set of these co-eligible next acts the **L1 cloud**: the collection of branching futures for the current present.

Key points:

* L1 is about **many possible continuations** from a given past.
* It lives at the level of:
  + “Here are all the candidate next presents that could follow.”
* It is responsible for the feeling that:
  + the future is **open**,
  + there is more than one way things could go.

Later, when we talk about quantum co-eligibility at −2 or many candidate causal paths at larger scales, L1 is the role capturing those “spread-out” possibilities before any selection is made.

**1.5.3 L2 — environment role: futures-as-experiences**

L2 is the role that treats those branching futures as **full experiences**, organized within a higher context.

If L1 is “the set of next steps from here,” then L2 is:

the next outward present that encodes which combinations of those L1 possibilities are being considered together as a *world*.

From our 0-centred perspective:

* L2 at +1 is the **environment**:
  + a present at +1 that:
    - hosts many 0s and their timelines,
    - encodes their possible relations and interactions,
    - forms what we call “a shared world.”

Inside that L2 environment:

* each L1 branch for your 0 is not just “a number in a list”;
  + it is part of a full **L2 experience** at +1,
  + where many branching futures of many 0s are coordinated together.

So:

* **L1**: many candidate next acts for a single 0.
* **L2**: a higher present that **bundles** many L1 branches (from many 0s) into coherent environmental experiences.

This is why L2 is often described as the **environment role**: it is the context in which branching futures are framed as scenes, worlds, or “states of the world.”

**1.5.4 L3 — unifier role: selecting one realized present**

L3 is the role that performs **unification**: it takes the many co-eligible L1 alternatives, organized in some L2 context, and ensures that **one and only one** continuation is realized in the history seen by a given 0.

In the engine, this corresponds to:

* evaluating feasibility gates,
* comparing candidates by discrete criteria (ratio-lex),
* and, *only if they are still exactly tied*, applying PF/Born to **select one**.

Conceptually:

* L3 is the role in which a present:
  + looks at a bundle of alternatives,
  + enforces all consistency constraints,
  + and “chooses” a single next present to become actual relative to a given past.

L3 is what keeps reality from drifting into a many-worlds fog **from the vantage of a single 0**: even if multiple alternatives remain co-eligible in principle, the L3 unifier role ensures that one specific continuation is actually experienced.

**1.5.5 Roles vs levels, and why this distinction matters**

It is crucial not to confuse **context levels** with **L-roles**:

* Context levels (−2, −1, 0, +1, +2, +3) tell us:
  + *where* a present stands relative to our 0:
    - inner, peer, or outer.
* L1/L2/L3 tell us:
  + *how* a present behaves in the branching–environment–selection process.

The same present can:

* be at level 0 (our organism),
* be at level +1 (environment for a smaller system),
* or at level −1 (inner part of a larger system),

and at the same time:

* play L1 role in one diagram (its own branching futures),
* play L2 role in another (environment for its inner parts),
* and play L3 role when it ensures that one outcome is realized for its own history.

Why this matters for the rest of the theory:

* When we talk about **quantum possibilities**, **classical worlds**, and **collapse**, we are really talking about:
  + L1 (possibilities),
  + L2 (world-like organization),
  + L3 (selection).
* When we describe **spacetime, gravity, and environment**, we are often describing:
  + L2 roles at +1, +2, +3.
* When we talk about **conscious experience and decision**, we are focusing on:
  + L3 choices and L1 futures at 0.

Keeping L1/L2/L3 clearly separate from −2/−1/0/+1/+2/+3 lets us:

* avoid mixing “where something sits in the context hierarchy” with “what role it is playing in the process of becoming,”
* and gives us a unified language to discuss:
  + physics (SR, quantum, gravity),
  + environment,
  + and experience,  
    using the same set of relational roles.

**Part II – V2 Present Act Engine (Math Core)**

**2.1 Local sites and selectors**

**2.1.1 Sites as discrete contexts**

In the V2 engine, the evolving “world” is represented as a collection of **discrete sites** arranged along a time-like index. We write sites as:

* (k \in \mathbb{Z}) or (k \in {0,1,2,\dots}),

depending on whether we allow negative indices, but in all cases each (k) labels a **local context** in the engine’s unfolding.

Key ideas:

* Each site (k) is a **finite locus of candidates** for what the world looks like “one step later” from some vantage.
* Updates are **local** in this index:
  + the engine only ever directly relates (k) to (k+1),
  + there are no long-range jumps like (k \to k+10) in control.
* This captures the “no-skip” idea: the engine moves in discrete neighbour steps, one act at a time.

**2.1.2 World and qualia records at each site**

At each site (k), the engine maintains two finite sets:

* (W\_k): a **world record**, containing candidates for the “outer” configuration (how +1 looks from this vantage).
* (Q\_k): a **qualia record**, containing candidates for the “inner” configuration (how 0’s inner experience looks).

We can think of these as:

1. (W\_k): hypotheses about the environment and outer relations at step (k),
2. (Q\_k): hypotheses about the inner/body/qualia state at step (k).

Important properties:

* Both (W\_k) and (Q\_k) are **finite**:
  + the engine never handles infinitely many candidates at once,
  + this keeps feasibility checks and selection finite and computable.
* The separation between (W\_k) and (Q\_k) reflects:
  + the distinction between **outer relational structure** (environment-facing side) and
  + **inner experiential structure** (0-facing side),
  + which later must be reconciled at the hinge.

**2.1.3 Local selectors (U) and (P)**

The evolution from one site to the next is governed by two selectors:

* $(U^{k \to k+1} \subseteq W\_k \times W\_{k+1})$:

a relation that connects world candidates at ($k$) to world candidates at ($k+1$).

* $(\Psi^{k \to k-1} \subseteq Q\_k \times Q\_{k-1})$:

a relation that connects qualia candidates at ($k$) to qualia candidates at ($k-1$) (for backward compatibility of inner states).

These selectors:

* **are relations** (adjacency lists), not probability kernels in control,
* **encode which transitions** between candidates are allowed at the level of simple adjacency (before gates, fit, etc.),
* **must be finite-support:**
  + each candidate in ($W\_k$) or ($Q\_k$) only has a finite number of neighbours in the next/previous site.

**Properties that matter:**

* **Locality:**
  + ($U^{k \to k+1}$) only connects ($k$) to ($k+1$),
  + there is no direct ($U^{k \to k+2}$) or “long-hop” relation in control.
* **Deterministic enumeration:**
  + given ($W\_k$) and ($Q\_k$) and the manifest, the engine can deterministically enumerate all candidate pairs ($(w\_{k+1}, q\_k)$) that will be checked at the hinge,
  + no randomness is used in the basic enumeration.

**2.1.4 Why selectors are relations, not kernels**

A key design choice in V2 is that selectors (U) and (P):

* are **purely structural**:
  + they state which candidate pairs are allowed as potential transitions,
  + they do not encode weights, probabilities, or amplitudes.
* This keeps the **control path** free of:
  + continuous weights,
  + fitted curves,
  + hidden field-like influences.

All probabilistic or amplitude-like behaviour arises **later**, and only:

* when there is an exact tie after all discrete feasibility tests,
* and the PF/Born mechanism is invoked on a finite tie set.

Thus:

* selectors define the **possible paths** the engine can consider,
* gates and fit define which of those paths are **feasible and preferred**,
* PF/Born only resolves *true equality* among survivors.

**2.1.5 Summary of the 2.1 structure**

Putting this together:

* The engine’s “world” is a chain of **sites** ($k$), each holding:
  + a finite set of world candidates ($W\_k$),
  + a finite set of qualia candidates ($Q\_k$).
* **Local selectors ($U$) and ($\Psi$):**
  + provide adjacency relations between candidates at neighbouring sites,
  + respect no-skip locality,
  + do not introduce weights or probabilities in control.

This gives us:

* a **discrete backbone for time** (the k-index),
* a **finite combinatorial structure** of possibilities at each step,
* and a clean separation between:
  + mere **possible transitions** (selectors),
  + **feasibility and fit** (gates and hinge equality),
  + and **random choice** (PF/Born ties-only).

Subsequent subsections will add:

* a finite feature alphabet and hinge equality (2.2),
* gate structure (2.3),
* ratio-lex acceptance and PF/Born ties-only (2.4),
* and typed budgets tying this all to SR (2.5).

**2.2 Finite feature alphabet & hinge equality**

**2.2.1 Feature alphabet as a finite set**

To compare world candidates ($w \in W\_{k+1}$) and qualia candidates ($q \in Q\_k$) at the hinge, the engine does not look at arbitrary, high-dimensional internal data. Instead, it extracts from each candidate a small, finite feature vector taking values in a finite alphabet ($\Xi$).

We define:

* A finite set ($\Xi$) of possible feature values:

$$[\Xi = \Xi\_{\text{phase}} \times \Xi\_{\text{disc}}]$$

where:

* + ($\Xi\_{\text{phase}}$) is a finite set of phase bins (e.g., indices $0,1,\dots,M\_{\phi}-1$), and
  + ($\Xi\_{\text{disc}}$) is a finite product of discrete tags (e.g., context band, shell index, orientation bin, lane labels, etc.).
* Two deterministic, act-local feature maps:

$$[f\_{k+1} : W\_{k+1} \to \Xi, \qquad g\_{k} : Q\_{k} \to \Xi.]$$

For each candidate:

* ($f\_{k+1}(w)$) encodes the **outer-side** feature abstraction of world candidate ($w \in W\_{k+1}$),
* ($g\_{k}(q)$) encodes the **inner-side** feature abstraction of qualia candidate ($q \in Q\_k$).

**Key properties:**

* **Finite:** ($\Xi$) is finite, and so are ($W\_{k+1}$), ($Q\_k$). This guarantees that all comparisons at the hinge are finite, combinatorial operations.
* **Act-local:** ($f\_{k+1}$) and ($g\_k$) depend only on:
  + the candidates at that step,
  + and the manifest configuration,
  + not on long histories or global diagnostics.
* **Re-centering-invariant:** If we shift indices by a constant (e.g., relabel $k \to k+k\_0$), ($f$) and ($g$) produce the same feature labels up to deterministic renaming, so hinge behaviour does not depend on arbitrary index choice.

**2.2.2 Phase bins and their relation to Θ**

The phase component of the feature alphabet (F\_{\text{phase}}) represents **discretized phase information** (e.g., angle-like degrees of freedom). Instead of using continuous phases (which would introduce real-valued comparisons into control), V2 uses:

* a finite number of phase bins (M\_\phi),
* with each bin representing a range of continuous phase values.

Crucially, the **phase resolution** (i.e., how fine the bins are) is tied to the **Θ (time) gate**:

* The manifest declares a Θ ladder:
  + a nested set of time windows (\mathcal{W}\_0 = {\omega\_1 < \dots < \omega\_m}) in 0-time (inner ticks).
* As part of hinge configuration, the manifest also declares:
  + a rule that derives (M\_\phi) (or a tolerance angle) from this Θ ladder:
    - shorter integration windows → coarser phase resolution,
    - longer windows → finer phase resolution.
* This linkage ensures:
  + the engine does not separately tune phase precision; it is **derived once** from temporal integration rules,
  + avoiding hidden continuous knobs in the comparison step.

Thus, the phase component is:

* discrete in control, and
* consistent with the temporal resolution at which acts are stabilized (Θ).

**2.2.3 Equality as the only form of “fit”**

At the hinge, fit between a world candidate and a qualia candidate is defined purely as equality of their features in the finite alphabet ($\Xi$). Formally:

* The hinge set is:

$$[H\_{k \to k+1} = \{ (w,q) \in W\_{k+1} \times Q\_k : f\_{k+1}(w) = g\_k(q) \}.]$$

There are no graded similarity scores, no inner products, no distances. A pair ($(w,q)$) either:

* **matches exactly** in the feature alphabet $\to$ it is eligible to pass the hinge (subject to gates), or
* **does not match** $\to$ it is discarded at this early stage.

This has several important consequences:

* **Decidability:**
  + Hinge matching is a purely combinatorial test in a finite set.
* **No soft scoring:**
  + We avoid introducing continuous similarity metrics or neural-network-style scores into the control path.
* **Simplicity and auditability:**
  + The full logic of fit can be inspected as:
    - “which finite tags must match?”,
    - and “which phase bins coincide?”,
  + making gate behaviour transparent and reproducible.

**2.2.4 No continuous similarity in control**

By design, the engine prohibits any notion of “almost equal” or “similar enough” in the **control** path:

* No Euclidean distances,
* No cosine similarities,
* No kernel functions,
* No logistic or softmax weights.

Any such notions—if used at all—are confined strictly to **diagnostics**, not to:

* selectors,
* gates,
* hinge equality,
* or acceptance.

At the control level:

* the only comparison is discrete equality in ($\Xi$),
* and gate predicates are all boolean/ordinal statements based on:
  + exact bin membership,
  + integer thresholds,
  + and simple combinatorial structure.

This guarantees that:

* the engine does not hide fitted curves or field-like structures inside seemingly simple selection rules,
* all “grading” of candidates happens at the level of counts and ratios later, not via analog similarity in fit.

**2.2.5 Role of hinge equality in the overall pipeline**

The hinge equality stage plays a specific role in the full update pipeline:

* **Selectors enumerate possible transitions:**
  + ($U$) picks candidate world next-steps,
  + ($\Psi$) ensures inner/qualia candidates are backward-compatible.
* **Hinge equality filters these down:**
  + only pairs ($(w,q)$) with ($f(w) = g(q)$) are considered as true **matches**.
* **Gates ($\Theta$, $\kappa$, structural, ParentGate, CRA):**
  + further filter candidates based on:
    - temporal stability ($\Theta$),
    - spatial/feature granularity ($\kappa$),
    - local connectivity and structural rules,
    - gravitational feasibility (ParentGate),
    - context-resolved admissibility (CRA).
* **Ratio-lex acceptance and PF/Born ties-only:**
  + compare surviving candidates using discrete ratios of pass/fail counts,
  + select a unique winner or, in case of exact ties, invoke PF/Born on the tie set.

Hinge equality is therefore the **first and simplest consistency check** between outer and inner candidates for an act:

* it enforces a **basic match** between what the environment proposes and what the inner 0-context proposes,
* at the level of a finite, explicitly specified feature alphabet.

Because it is purely equality-based, finite, and tied to the $\Theta$ ladder for its only continuous-like aspect (phase), it is:

* **fully compatible** with the engine’s design constraints (no curves, no hidden weights in control),
* and provides a clear, auditable foundation for all subsequent feasibility and selection steps.

**2.3 Feasibility gates**

**2.3.1 Purpose and position in the pipeline**

After selectors and hinge equality have identified which world–qualia pairs ((w, q)) are potential matches, the engine still needs to decide which of these candidates are **feasible acts** for the next present. This is done by a series of **gates**—tests that each candidate must pass to remain in the running.

These gates:

* act on the finite set of candidate pairs that passed hinge equality,
* are all **boolean or ordinal** (pass/fail or integer thresholds),
* never assign real-valued scores or weights,
* are applied in a fixed order before any acceptance scoring or PF/Born randomization.

Conceptually, feasibility gates answer:

* “Is this candidate act coherent in time?” (Θ),
* “Is it coherent in space/feature resolution?” (κ),
* “Is its local structure acceptable?” (structural gates),
* “Is it compatible with the gravitational feasibility gradient?” (ParentGate),
* “Does it resolve context ambiguities appropriately?” (CRA-like gates).

Only candidates that pass all required gates become **eligible survivors** for the later ratio-lex acceptance step.

**2.3.2 Θ (time gate) – minimal integration window**

The **Θ gate** ensures that a candidate act is **temporally stable enough** to count as one present-act.

Idea:

* Every act must be supported by configuration stability over a **minimal time window** in 0-time (inner ticks).
* This prevents fleeting, transient configurations from being treated as full acts.

Implementation outline:

* The manifest declares a **Θ ladder**:
  + a set of increasing inner-time windows (\mathcal{W}\_0 = {\omega\_1 < \omega\_2 < \dots < \omega\_m}).
* For a given candidate, the engine:
  + evaluates its relevant feature and structural patterns across this ladder,
  + looks for a smallest (\omega\_\star) such that:
    - the candidate’s features/structure remain within tolerances throughout ([k-\omega\_\star, k]).

If such a minimal stabilizing window (\omega\_\star) exists, the candidate **passes Θ**. If not, it fails and is discarded.

Key properties:

* **Boolean**: pass (stable over some window) or fail (no window provides stability).
* **Monotone**: if a candidate is stable for (\omega\_\star), it remains stable for any longer window (\omega \ge \omega\_\star) in the same run.
* **No curves**: no graded “how stable” score is used in control; only the existence of sufficient stability matters.

Θ thus encodes the idea that:

A present-act must be supported by a minimal integration of time; extremely brief fluctuations do not qualify as full acts.

**2.3.3 κ (granularity gate) – coarsest persistent resolution**

The **κ gate** addresses **spatial/feature granularity**: it ensures that an act is coherent at an appropriate spatial or feature resolution.

Idea:

* The engine works across multiple discrete scales (spatial, feature, frequency, etc.).
* κ enforces that a candidate pattern is stable at some **coarse enough resolution** to count as a part of the present.

Implementation outline:

* The manifest declares a **granularity ladder**:
  + (\mathcal{G}\_+ = {g\_1 > g\_2 > \dots > g\_M}),
  + where each (g\_i) is a coarser resolution than (g\_{i+1}).
* For a given candidate, the engine:
  + applies an aggregation operator at each granularity (g) (e.g., spatial binning, pooling in feature space),
  + checks whether the candidate’s pattern **persists** across one or more steps at granularity (g) (e.g., from (k) to (k+1)).
* The candidate passes κ if there exists a coarsest (g\_\star) such that:
  + pattern persists at (g\_\star),
  + and we can treat that granularity as its effective “part size.”

If such a (g\_\star) exists, κ records it (for diagnostics) and the candidate **passes**. Otherwise, it fails.

Key properties:

* **Boolean**: a candidate either has a persistent representation at some granularity or it doesn’t.
* **Monotone**: once persistence is found at a certain coarse level, finer levels may add detail but do not invalidate the existence of persistence.
* **No weights**: κ does not assign scores; it just checks for persistence across a discrete ladder.

κ thus expresses:

A feasible act must be representable at some stable granularity; structure that only exists at vanishingly fine scales, without stability at any coarser level, does not count as part of the present.

**2.3.4 Structural gates: contiguity, min-degree, orientation, L3 persistence**

Beyond temporal and granular stability, we need to ensure that candidate acts have reasonable **local structure**. This is enforced by a set of structural gates, all boolean predicates checked on the candidate’s local connectivity and geometric relationships.

Examples include:

* **Contiguity gate**:
  + Ensures that relevant components of a candidate act form a **connected region** under the engine’s adjacency structure.
  + Rejects candidates that would cause “disconnected” fragments to suddenly act as one without plausible mediating relations.
* **Minimum-degree gate**:
  + Ensures each key element has at least a minimal number of neighbours (connections) in the candidate.
  + This prevents unstable tree-like spikes or isolated nodes from being treated as robust parts.
* **Orientation-uniqueness gate**:
  + Enforces that, within the local equivalence class (same context band, granularity, etc.), only one representative orientation is admissible.
  + Rejects duplicates that differ only by symmetric rotations that the manifest has chosen to treat as equivalent.
* **L3-persistence gate**:
  + Ensures that certain structural features required for consistent sequences (e.g., continuity of a worldline, direction of travel) are not prematurely broken.
  + Prevents acts that would cause L3 (unifier) to lose track of consistent lineage from site to site.

All these gates:

* are computed from **local combinatorial structure** (graphs, adjacency lists, discrete labels),
* are **yes/no** tests,
* never assign soft scores or weights.

They encode minimal structural sanity checks for what counts as a plausible act in the evolving relational network.

**2.3.5 ParentGate – gravitational feasibility**

ParentGate, described in more detail later under gravity, is also a **boolean gate** in this pipeline. It encodes how likely outward moves are at different radii from a mass-like center.

At the feasibility stage, we only need to remember:

* ParentGate:
  + uses integer shell indices around centers,
  + has an inward-monotone strictness schedule,
  + is rotation-invariant in expectation,
* and it simply:
  + allows or disallows candidate acts based on these rules,
  + without scoring or weighting them.

ParentGate is the only gate that encodes gravity-like effects; no other gate is permitted to include radius-dependent feasibility gradients.

**2.3.6 CRA-like gates – context-resolved admissibility**

CRA (Context-Resolved Admissibility) and related gates enforce that:

* candidates that look the same **at the hinge** but belong to different broader contexts (e.g., different bands, shells, or roles) are treated carefully,
* in situations where two families of candidates could “collapse onto the same rail” and create ambiguity, CRA can:
  + reject both,
  + or require additional structural distinctions.

Intuitively:

* CRA prevents the engine from making common-mode commits where two different context families behave identically at the current resolution.
* It enforces that **each commit is resolved in a way that preserves distinguishable contexts** where needed.

Again, CRA-like gates:

* are boolean predicates,
* operate on discrete tags (band labels, lane labels, context ids),
* do not introduce continuous weights.

They ensure that **feasibility and admissibility are context-aware**, preventing pathological cases where distinct context branches would be collapsed into an indistinguishable single line without justification.

**2.3.7 All gates are boolean/ordinal and pre-score**

To summarize the role of feasibility gates:

* Every gate (Θ, κ, structural, ParentGate, CRA-like) is:
  + **boolean** (pass/fail) or **ordinal** (integer thresholds),
  + never real-valued or curve-based in control.
* They are applied in a fixed order:
  + Hinge equality (fit on finite alphabet),
  + Θ (time stability),
  + κ (granularity persistence),
  + Structural gates (contiguity, degree, orientation, L3 persistence),
  + ParentGate (gravity schedule),
  + CRA-like gates (context-resolved admissibility).
* Only candidates that pass **all** required gates become survivors for:
  + ratio-lex comparison (2.4),
  + and possible PF/Born resolution in case of exact ties.

By keeping all gates purely boolean/ordinal and confining them to a **pre-scoring feasibility phase**, the engine guarantees that:

* feasibility is auditable and transparent,
* no hidden curves or weights enter the control path,
* and all probabilistic behaviour is restricted to the PF/Born ties-only step, as intended.

**2.4 Ratio lex acceptance & PF/Born ties only**

**2.4.1 Survivors from feasibility and residuals**

After selectors, hinge equality, and all feasibility gates (Θ, κ, structural, ParentGate, CRA-like), we are left with a **finite set of survivors** for the next act:

* Call this set (\mathcal{C} = {c\_1, c\_2, \dots, c\_N}),
* where each (c\_i) is a world–qualia pair ((w\_i, q\_i)) that:
  + matched at the hinge (finite alphabet equality),
  + and passed all gates.

The engine now needs to choose **one** of these survivors to commit as the actual next present-act for this site.

To compare survivors, the engine computes **residuals** for each candidate, based on how many checks failed vs how many were applied in different “channels”:

* For each (c), we define a **residual triple**:  
  [  
  \mathbf{d}(c) = \big(d\_{\text{out}}(c), , d\_{\text{in}}(c), , d\_{\times}(c)\big)  
  ]  
  where:
  + (d\_{\text{out}}(c)) = fraction of **outward** (world-side) structural checks that failed,
  + (d\_{\text{in}}(c)) = fraction of **inward** (qualia-side) checks that failed,
  + (d\_{\times}(c)) = fraction of **cross** checks (hinge consistency, context alignment, etc.) that failed.

Each component is a **ratio**:

1. failed\_checks / total\_checks,
2. so each component lies in ([0, 1]).

Residuals capture, in a strictly discrete way, **how many constraints** a candidate violates, normalized by how many were applied. There are no continuous weights or scores beyond these ratios.

**2.4.2 Lexicographic ordering of residuals**

To rank candidates, the engine does **not** combine the residual components into a single weighted sum. Instead, it uses a **lexicographic order** on the residual triples:

* First, compare (d\_{\text{out}}(c)) for all survivors:
  + Candidates with smaller (d\_{\text{out}}) are strictly preferred.
  + Outward/world-side coherence has highest priority.
* Among those tied on (d\_{\text{out}}) (within a tiny, declared ε-zeroing tolerance), compare (d\_{\text{in}}(c)):
  + Candidates with smaller (d\_{\text{in}}) are preferred.
  + Inward/qualia-side coherence is next in priority.
* Among those tied on both (d\_{\text{out}}) and (d\_{\text{in}}), compare (d\_{\times}(c)):
  + Candidates with smaller (d\_{\times}) are preferred.
  + Cross/hinge consistency is resolved last.

A small **zeroing tolerance** ε (declared in the manifest and tied to Θ) is used to treat very small residuals as zero, but:

* This tolerance is fixed per run,
* It is not adjusted per condition or per candidate,
* It exists only to handle exact vs nearly-zero numeric representation in a controlled way.

Crucially:

* No linear combinations like (\lambda d\_{\text{out}} + \mu d\_{\text{in}} + \nu d\_{\times}) are permitted.
* The order of priorities is fixed and **unweighted**.
* This makes the acceptance rule:
  + transparent,
  + finite,
  + and free of hidden “importance weights” in control.

**2.4.3 Fewest-acts tie-break**

It can happen that after lexicographic comparison:

* multiple candidates still have **exactly the same** residual triple (\mathbf{d}), after zeroing,
* i.e., they are indistinguishable in terms of outward, inward, and cross failure ratios.

Before introducing any randomness, the engine applies a further purely **ordinal tiebreak**:

* **Fewest-acts**:  
  prefer the candidate whose history so far uses the fewest total acts or has the smallest accumulated “length” according to a simple integer measure (e.g., number of steps or a declared path-length counter).

Intuition:

* this tiebreak chooses the **simplest / shortest** feasible continuation among otherwise equal alternatives,
* corresponding to a kind of discrete “geodesic” preference.

Properties:

* The fewest-acts measure is:
  + integer-valued,
  + declared up front in the manifest (how it is computed),
  + not subject to any continuous weighting.
* It still may leave multiple candidates tied (e.g., two paths with identical residuals and identical act counts).

**2.4.4 PF/Born ties only**

Only when **all** of the following hold:

* residual triples are identical (after ε-zeroing),
* fewest-acts tiebreak has not singled out a unique winner,
* the tie set (\mathcal{T} \subseteq \mathcal{C}) has size (|\mathcal{T}| \ge 2),

does the engine invoke the **PF/Born mechanism**:

* Build a **tie adjacency** structure for (\mathcal{T}):
  + Each candidate in (\mathcal{T}) may have simple adjacency relations to others (e.g., based on which structural patterns they share),
  + This is represented as a small adjacency graph or matrix.
* Construct a **primitive kernel** (M) on (\mathcal{T}):
  + (M) is a column-stochastic matrix:
    - entries reflect adjacency in a symmetric, neutral way,
    - a tiny (\eta > 0) may be added to ensure primitivity (every state reachable in some number of steps).
  + No fitted weights or external data are used:
    - the kernel is defined entirely from combinatorial adjacency and the manifest.
* Compute the **Perron–Frobenius eigenvector** (v) of (M):
  + (v) has strictly positive components,
  + is unique up to scaling,
  + represents a neutral “stationary” distribution over the tie set.
* Define **Born-style weights**:
  + (w\_j \propto v\_j^2) for each candidate (j) in (\mathcal{T}),
  + normalized so (\sum\_j w\_j = 1).
* Use a RNG (with declared seed and family) to **sample one candidate** from ({w\_j}):
  + that candidate is selected as the survivor,
  + all other tie candidates are discarded for this act.

Key points:

* PF/Born is **only** used on **exact ties** after all discrete ordering steps; it never comes into play otherwise.
* The kernel structure and eigenvector are:
  + determined entirely by local adjacency and manifest-declared rules,
  + not tuned to empirical frequencies,
  + not shaped by any fitted amplitudes in control.

**2.4.5 No hidden probabilities or weights in control**

The acceptance rule has been carefully designed to ensure:

* **All weighting and probabilistic behaviour is confined to the PF/Born step** and only for exact ties.
* Everywhere else in control:
  + selectors: purely relational adjacency (no probabilities),
  + hinge equality: exact equality in finite alphabet (no similarities),
  + gates: boolean/ordinal predicates (no soft thresholds),
  + residuals: simple ratios of failed/total checks (no learned weights),
  + lex order + fewest-acts: purely discrete priority rules.

Therefore:

* There is no place in control where a continuous weight, a curve, or a learned metric can sneak in.
* Any probabilistic choice is a result of:
  + an explicitly constructed neutral kernel,
  + whose mapping to Born weights is fixed by the theory.

This makes the acceptance logic:

* fully auditable,
* deterministic given the tie set, the manifest, and the RNG seed,
* and consistent with the requirement that **present-act selection is fundamentally discrete and relational**.

**2.4.6 Relationship to quantum behaviour**

The PF/Born ties-only rule is also the bridge to **quantum behaviour** in this framework:

* At the −2 seam, it is common for:
  + many micro-histories to remain co-eligible up to the hinge,
  + even after feasibility gates and structural checks.
* When such a set of micro-histories becomes tied at the acceptance stage:
  + the PF/Born rule chooses a single outcome,
  + giving rise to:
    - quantum-like collapse,
    - Born-rule probabilities,
    - and entanglement correlations (when tie sets are correlated across systems).

From the present-act perspective:

* “Wavefunction” and “amplitude” are effective descriptions of:
  + the structure of tie sets and adjacency relations in (\mathcal{T}).
* The Born rule is:
  + encoded directly in the **PF/Born ties-only mechanism**,
  + not an extra axiom slapped on later.

By enforcing PF/Born only on exact ties and nowhere else, the engine:

* recovers the probabilistic character of quantum measurements where it is needed (at −2),
* while keeping the rest of the dynamics **deterministic and discrete** at the level of acceptance and feasibility.

**2.5 Typed budgets & SR identity**

**2.5.1 Typed budgets per act**

For each committed present-act, the engine records a **typed budget triple**:

[  
(\Delta \tau, \Delta t, \Delta x)  
]

where:

* (\Delta \tau) is the **inner-time increment** (0-time):
  + measured in integer ticks of the 0-context’s own act clock,
  + represents how much of the act is spent on inward integration (“keeping inner relations together”).
* (\Delta t) is the **outer-time increment** (+1-time):
  + measured in integer ticks of the +1 container’s public clock,
  + represents how much the shared environment’s “time” advances during this act.
* (\Delta x) is the **outer-space increment**:
  + measured in discrete units of outward traverse,
  + represents how far the worldline has moved in +1 coordinates (e.g., how much the 0-context’s position in the environment has changed).

These quantities are **typed**:

* (\Delta\tau \in \mathbb{T}\_0) (inner-time tick set),
* (\Delta t \in \mathbb{T}\_{+1}) (outer-time tick set),
* (\Delta x \in \mathbb{L}) (spatial units set).

The engine does not think in terms of real-valued seconds and metres. Instead, it uses:

* integer or rational increments in these typed sets,
* with a separate **unit map** (c) relating (\mathbb{T}*0) and (\mathbb{T}*{+1}) (see below).

**2.5.2 Single unit map (c) between inner and outer time**

The relationship between inner-time ticks (\mathbb{T}*0) and outer-time ticks (\mathbb{T}*{+1}) is fixed by a single **unit map**:

[  
c : \mathbb{T}*0 \to \mathbb{T}*{+1}  
]

In practice:

* (c) is serialized in the manifest as a rational, e.g., "inner\_per\_outward": "p/q",
* conversion between inner and outer ticks uses only that rational mapping,
* no floating-point scaling or per-scene retuning is allowed in control.

Intuitively:

* (c) encodes **how much outward traversal per inner act** the hinge 0↔+1 supports:
  + it is the discrete analogue of “speed of light” in our context,
  + but it is treated as a fixed conversion factor, not as a free parameter to be re-fitted for different experiments.

Because this mapping is declared only once per run and never altered mid-run, all budget calculations and SR behaviour are anchored to the **same** conversion rule.

**2.5.3 Budget identity: discrete Minkowski relation**

The typed budgets obey a **typing identity** that looks like a discrete version of the Minkowski interval:

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

Interpretation:

* (\Delta t^2) is the squared outer-time interval,
* (\Delta \tau^2) is the squared inner-time (proper-time) interval,
* (\Delta x^2 / c^2) is the spatial contribution, converted into outer-time units via (c).

This is not a “metric postulate added later”; it is:

* a **typing constraint** on how budgets are assigned per act,
* enforced by the engine whenever it commits an act:
  + if a candidate act’s proposed ((\Delta\tau, \Delta t, \Delta x)) doesn’t satisfy the identity under the declared unit map (c), it is invalid and cannot be committed.

Consequences:

* Each act’s budgets are internally consistent by construction.
* Over sequences of acts (worldlines), summing these budgets produces emergent spacetime structure (cones, time dilation, etc.) consistent with SR, without having to separately assume a continuum metric.

**2.5.4 Additivity and worldlines**

For a given worldline (sequence of acts (c\_1, c\_2, \dots, c\_N)), budgets add:

[  
\Delta \tau\_{\text{tot}} = \sum\_{i=1}^{N} \Delta \tau\_i, \quad  
\Delta t\_{\text{tot}} = \sum\_{i=1}^{N} \Delta t\_i, \quad  
\Delta x\_{\text{tot}} = \sum\_{i=1}^{N} \Delta x\_i.  
]

The identity per act:

[  
(\Delta t\_i)^2 = (\Delta \tau\_i)^2 + \frac{(\Delta x\_i)^2}{c^2}  
]

does not directly imply the global identity with sums (since it is quadratic), but:

* the **no-skip** condition (every step increments outer-time by one unit),
* together with per-act budget constraints,
* and the fact that each step respects the same unit map c,

ensures that:

* any effective speed (|\Delta x\_{\text{tot}} / \Delta t\_{\text{tot}}|) over a worldline is bounded by (c),
* and that the accumulated proper time (\Delta\tau\_{\text{tot}}) for different worldlines between the same outer events follows the familiar SR patterns (time dilation, etc.).

We can think of a worldline as:

* a path in a discrete lattice of typed budgets,
* where each step is constrained by the same local relation and conversion (c),
* and emergent SR geometry arises from many such steps, not from a separate continuum backdrop.

**2.5.5 Light-cones and maximum speed from budgets**

Because of the budget identity and no-skip rule, each act obeys:

[  
\left|\frac{\Delta x}{\Delta t}\right| \le c  
]

since (\Delta \tau^2) must be non-negative.

This inequality guarantees:

* no act can involve an effective speed greater than (c),
* thus, no worldline composed of such acts can surpass (c) either.

Geometrically:

* The set of reachable ((\Delta t, \Delta x)) pairs from a given event is constrained to lie **inside or on** the discrete analogue of a light cone.
* The engine never needs to “enforce” a speed limit separately—it's built into how budgets are allowed to be assigned.

Thus:

* **Light-cones** and the **maximum speed** (c) are emergent from:
  + the typed identity,
  + the fixed unit map (c),
  + and the discreteness + no-skip composition,
* not from an externally imposed spacetime metric.

**2.5.6 Time dilation and length contraction as budget effects**

Given two different worldlines between the same outer-time interval (\Delta t\_{\text{tot}}):

* one that “moves more” (larger total (|\Delta x\_{\text{tot}}|)),
* one that “moves less” (smaller total (|\Delta x\_{\text{tot}}|)),

their inner-time budgets (\Delta\tau\_{\text{tot}}) will differ because of the identity:

[  
(\Delta t)^2 = \Delta \tau^2 + \frac{\Delta x^2}{c^2}.  
]

Intuitively:

* A worldline that allocates more budget to spatial traverse (\Delta x) must allocate less to inner-time (\Delta\tau) for a fixed (\Delta t),
* So a “fast-moving” worldline accumulates **less proper time** (inner-time) than a “slow-moving” one over the same outer-time interval.

In continuum language, this is exactly **time dilation**; in the engine, it is:

* a bookkeeping consequence of how budgets are assigned per act under the fixed identity.

Similarly, effects analogous to **length contraction** arise when:

* we interpret (\Delta x) for objects in different motion states,
* under the same budget constraints and unit map.

No separate “SR machinery” is required; all such behaviour follows from:

* typed budgets,
* the identity per act,
* and consistent composition of acts.

**2.5.7 Summary: SR built into budgets, not added on top**

The V2 engine encodes SR-like structure directly in its **typed budgets** and **unit map**:

* Every act carries a triple ((\Delta \tau, \Delta t, \Delta x)),
* These satisfy the discrete Minkowski-style identity with a single conversion (c),
* No step can exceed speed (c),
* Light-cone-like constraints, time-dilation-like behaviour, and emergent metric properties all arise from this setup.

This means:

* Special relativity is **not** an extra layer bolted on after the fact.
* It is a **native property** of how the present-act engine allocates and tracks inner and outer time and space at the 0↔+1 hinge.

Later sections will show how:

* Gravity (ParentGate + χ),
* and quantum behaviour (PF/Born at ties, especially at −2),

all fit into this same budget-respecting framework, without altering the fundamental SR structure encoded here.

**2.6 Manifest and audits**

**2.6.1 Role of the manifest**

The **manifest** is the fixed configuration document that defines everything the engine is allowed to do in a given run. It plays the role of a contract:

* It pins down all **control-side choices**:
  + the unit map (c),
  + hinge and context settings (UGM, bands),
  + gate ladders (Θ, κ, structural, ParentGate, CRA),
  + tie-kernel recipe for PF/Born,
  + audit configuration and tolerances.
* It separates:
  + what is **structural and fixed** for the run (in the manifest),
  + from what is **measured and reported** (in diagnostics).

Nothing in the control path is allowed to be modified dynamically by the data. If something needs to change, it must be expressed as a new manifest (a new run configuration). This ensures that:

* the engine’s behaviour is fully determined by the manifest + input data,
* and any claims about what the engine does are reproducible by re-running with the same manifest.

**2.6.2 What the manifest pins**

At a minimum, the manifest includes:

* **Unit map and budgets**
  + the rational mapping for (c) (inner\_per\_outward),
  + any fixed choices for tick normalization (e.g., how many acts per tick).
* **Hinge and context configuration**
  + UGM and other hinge scales, as used to:
    - classify context bands (−2…+3),
    - derive phase binning or tolerances from Θ,
    - define shell radii for ParentGate.
  + labels and parameters for bands (e.g., thresholds in absolute units or decoded units).
* **Gate ladders and parameters**
  + Θ ladder: list of time windows in inner ticks.
  + κ ladder: list of granularities or levels of spatial/feature aggregation.
  + Structural gate rules:
    - contiguity, degree thresholds, orientation equivalence rules, etc.
  + ParentGate schedule:
    - shell indices, strictness integers (m\_k), phase\_by\_shell rules.
  + CRA-like rules:
    - which context tags, lane labels, or band labels are used,
    - how to handle common-mode configurations.
* **Tie-kernel recipe for PF/Born**
  + how to build adjacency within a tie set,
  + how to construct the primitive kernel (M),
  + how to compute (v) and derive weights (w\_j \propto v\_j^2),
  + RNG family and seeding policy.
* **Audit configuration**
  + which audits must run (curve-ban, diagnostics-leak, SR compatibility, isotropy, monotonicity, no-signalling, etc.),
  + tolerances for each audit (e.g., maximum allowed deviation in c, γ, isotropy measures),
  + locations of any reference data or constants (for Earth-scale, Universe-scale, etc., in the gravity context).

Everything that can influence feasibility or acceptance must be declared in the manifest, not scattered through the code or learned from data.

**2.6.3 Audits: enforcing the engine contract**

Audits are systematic checks that run alongside or after the simulation, confirming that:

* the engine obeyed its own rules during the run,
* and no forbidden behaviour or hidden tuning occurred.

Key audits include:

1. **Curve-ban / weight-ban in control**
   * Static checks (on code/config):
     1. no float literals in control logic,
     2. no use of “weight,” “scale,” “logistic,” “softmax,” etc. where they would introduce continuous scoring.
   * Ensures:
     1. all gating and acceptance is boolean/ordinal and ratio-based,
     2. no hidden curve-fitting in control.
2. **Diagnostics-leak ban**
   * Dataflow / taint analysis:
     1. ensure no control-side logic reads from any diagnostics.\* fields.
   * Ensures:
     1. measured outcomes (counts, fits) cannot feed back into feasibility or selection,
     2. no “training on the fly” or adaptive reweighting.
3. **Locality / no-skip**
   * Verify:
     1. transitions only occurred between immediate neighbours (k→k+1),
     2. no long-hop transitions or retro-causal steps.
   * Ensures:
     1. discrete causal structure is respected.
4. **Measure and hinge invariance**
   * Check:
     1. phase bin counts (M\_\phi), phase-tolerance and residual-zeroing rules remain constant throughout the run,
     2. hinge/Θ files are read once and not modified.
   * Ensures:
     1. the hinge is not silently re-tuned per scene or condition,
     2. cross-condition comparisons are meaningful.
5. **PF/Born ties-only integrity**
   * Log and check:
     1. every use of PF/Born corresponds to an actual exact tie after ratio-lex + fewest-acts,
     2. tie sets and kernels are constructed as specified in the manifest.
   * Ensures:
     1. probabilistic behaviour only occurs where it is supposed to,
     2. no soft probabilistic choices are being made elsewhere.

**2.6.4 Domain-specific audits (SR, gravity, quantum, etc.)**

In addition to the generic audits, there are **domain-specific** checks:

* **SR compatibility**
  + Check:
    - that effective light-cones and speed c remain consistent across the run,
    - that γ(α) relationships match the SR identity in appropriate regimes.
  + Ensures:
    - typed budgets and no-skip indeed reproduce SR-like behaviour.
* **Gravity-specific audits (when ParentGate is used)**
  + Isotropy tests:
    - no preferred direction in pass/fail statistics at fixed radius.
  + Monotonicity:
    - strictness and effective rejection rates increase inward.
  + Surface neutrality:
    - measured c does not change at O(χ) when gravity is turned on.
  + Horizon neutrality:
    - inner regions near any horizon are rotation-invariant and unbiased.
  + No-signalling:
    - local outcomes not affected by distant ParentGate configurations or toggles.
* **Quantum/no-signalling audits (for −2 seam behaviour)**
  + CHSH / no-signalling tests:
    - verifying that any quantum-like correlations do not allow signalling,
    - ensuring PF/Born + CRA gates behave as intended across bands.

These audits guarantee that **special-purpose setups** (e.g., gravity runs, quantum experiments, interference tests) behave within the constraints of the overall engine.

**2.6.5 Why the manifest + audits matter for this theory**

The manifest and audits are not incidental implementation details; they are the **mechanism by which the theory keeps itself honest**.

* The theory’s core claims—no curves in control, equality-fit at hinges, PF/Born ties-only, typed budgets, separation of control vs diagnostics—are strong and restrictive.
* To be meaningful, they must be:
  + operationalized in explicit manifest entries,
  + actively enforced by audits.

This has several advantages:

* **Reproducibility**  
  A run is fully specified by:
  + input data,
  + manifest,
  + and RNG seed(s).  
    Anyone can re-run the same manifest and obtain the same control decisions and, up to randomness at ties, the same distribution of outcomes.
* **Falsifiability of implementation**  
  If an audit fails (e.g., a curve is detected in control, diagnostics leak into gating, SR compatibility is broken), then:
  + that run does *not* count as a valid test of the theory,
  + the implementation must be corrected.
* **Conceptual clarity**  
  It makes it precise what is **baked into the theory** (engine rules, context structure, hinge relationships) versus what is **empirical** (data, outcomes, fitted envelopes in diagnostics).
* **Defensive publication integrity**  
  For a defensive publication, it is important not just to state the theory, but to show:
  + how one would lock it into a manifest,
  + how one would ensure no hidden tuning or cheating is allowed,
  + and how every run can be checked against these constraints.

In short, the manifest and audits provide the **operational backbone** linking the philosophical and mathematical structure of V2 to concrete simulations and empirical tests in a way that is verifiable and transparent.

**Part III – Context Ladder and Role Geometry**

**3.1 Six bands and their roles**

**3.1.1 Why talk about “bands” at all?**

Up to now, we have treated context levels (−2, −1, 0, +1, +2, +3) as **roles** relative to our organism-centred present (0), and we have seen how those roles show up as “inside,” “outside,” and “environment” in our experience. But roles alone do not yet say **at what scales** these contexts tend to live.

Empirically, when we look across many domains—materials, biology, geology, astrophysics—we do not find a smooth, scale-free continuum of structure. Instead, we see repeated evidence for **finite scale bands** where behaviour changes qualitatively:

* fractal scaling breaks or changes exponent,
* characteristic sizes appear again and again,
* morphology shifts from “inner plexity” to “boundary-like” to “container-like.”

In this theory, those empirical bands are taken seriously as the **scale expression** of the context ladder. Each band is not just “a convenient range of sizes”; it is where a particular **context role** (−2, −1, 0, +1, +2, +3) is most naturally instantiated in our vantage.

Thus, the six bands are:

* a **scale hierarchy** that matches the **context-role hierarchy**,
* and together they define the backbone of how space, matter, life, and gravity are organized around our 0↔+1 hinge.

**3.1.2 The six bands around our hinge**

From the standpoint of our organism (0) inside the Earth-surface environment (+1), the six bands can be summarized as follows:

* **−2 band – Nanoband (deep inner seam)**  
  Typical scale: ~1–200 nm.  
  Role:
  + Deep inner context where +1’s ability to represent structure “runs thin.”
  + Many micro-configurations remain co-eligible from the +1 point of view.
  + Quantum and biomolecular behaviour (tunnelling, superposition, delicate coherence) appear here.  
    Examples:
  + DNA double helix diameter and base-pair length scales,
  + chromatin nanodomains,
  + nanoporous structures, small clusters, conduction channels.
* **−1 band – Micron band (cell/tissue level)**  
  Typical scale: ~0.2–50 µm, with a strong sub-band ~0.5–10 µm (“cell-core lane”).  
  Role:
  + Immediate inner context of 0: cells and micro-tissue units.
  + Building blocks from which 0’s body and organs are constructed.
  + Many biological processes (cell division, local signalling) naturally live here.  
    Examples:
  + single cells, bacterial colonies,
  + microvilli, villi, small glandular structures,
  + micro-roughness features in materials and tissues.
* **0 band – UGM band (organism pixel / hinge band)**  
  Typical scale: ~0.1–0.12 mm (UGM ~ 0.12 mm).  
  Role:
  + The **first “as-one-with-parts” scale** for organisms.
  + Smallest grain at which an organism can treat inner structure as usable parts in a single act.
  + Spatial pixel of the 0↔+1 hinge in this theory.  
    Examples:
  + smallest cross-sections for functional nerves and capillaries,
  + characteristic roughness or feature size at which surfaces become “visible” structure,
  + minimal sizes for distinct “features” in the conscious scene (e.g., smallest meaningful dot or speck).
* **+1 band – Earth-surface band (environment of organisms)**  
  Typical scale: ~1–100 km, with a kilometric GM cluster ~5–10 km.  
  Role:
  + Immediate environment of 0-contexts: the world of landscapes, weather, ecosystems, and human-scale geography.
  + The band in which “space” as we experience it (cities, mountains, coastlines) is most naturally expressed.  
    Examples:
  + size of towns, river segments, coast segments,
  + width of storm systems, mesoscale atmospheric structures,
  + distances across familiar geographic regions.
* **+2 band – Galactic disk band**  
  Typical scale: ~0.3–4 kpc.  
  Role:
  + The context in which Earth and similar planetary systems are embedded.
  + Acts as a **container** for many +1 worlds.
  + Largely sheet- or disk-like structures (spiral arms, HI and HII distributions).  
    Examples:
  + thickness and radial segment scales of the Milky Way disk,
  + scales of spiral arm segments and star-forming complexes.
* **+3 band – Cosmic shell / horizon band**  
  Typical scale: tens–hundreds of Mpc up to ~Gpc.  
  Role:
  + Outermost context accessible to us: cosmic web, last-scattering surface.
  + Acts as a **shell** or horizon around our galaxy and local group.
  + Structures here often have effective fractal dimension ≈ 2 (surface-like sheets and shells).  
    Examples:
  + supercluster walls and filaments,
  + CMB anisotropy structure at large angles,
  + the “edge” of the observable universe from our vantage.

Each band is thus a **scale expression** of one context role:

* −2: inner seam,
* −1: building-block cells/tissues,
* 0: organism pixel (UGM band),
* +1: Earth-surface environment,
* +2: galactic container,
* +3: cosmic shell.

Later sections will connect these bands to specific datasets (GM pivots, D(L) plateaus) and show that they appear again and again in empirical work, far beyond conceptual convenience.

**3.1.3 How these bands tie back to context roles**

The six bands are not just rough size categories; they encode the same relational structure that we described earlier:

* **−2**:  
  Where 0 sees “what my parts are made of” but cannot fully resolve them at +1; quantum/biomolecular seam.
* **−1**:  
  Where 0 sees “my parts” (cells and local units) as inner structure.
* **0**:  
  Where 0 itself is the centre of experience—large enough to have parts, small enough to be a part of +1.
* **+1**:  
  Where 0’s environment (the world) lives and where our main notion of “space” comes from.
* **+2**:  
  Where collections of +1 worlds (planetary systems) are grouped into galactic containers.
* **+3**:  
  Where those containers are themselves enclosed in a cosmic horizon.

Thus, the **scale ladder** and the **context-role ladder** are the same structure seen from two angles:

* scale bands = **how big** typical structures are when they play a given context role,
* context levels = **how those structures relate** to our 0-context (inner, peer, outer).

This provides the framework that will be used later when:

* we interpret quantum behaviour at −2,
* biological and sensory constraints at −1 and 0 (UGM),
* gravitational and cosmological behaviour at +1, +2, +3,

all as expressions of the same nested-context geometry around our present.

**3.2 Static evidence: GM pivots & D(L) seams**

**3.2.1 −2 CL: nanoband (1–200 nm)**

At the **−2 context level**, the theory predicts a “deep inner seam” where our +1 representation begins to lose the ability to pin down microstructure uniquely. Empirically, this seam shows up in a **nanometre-scale band**, roughly 1–200 nm, across a wide variety of systems:

* **Complex porous materials** (e.g., silica aerogels):  
  Finite fractal scaling windows in scattering experiments often span from ~1 nm up to tens or hundreds of nm, with geometric-mean (GM) pivots in the 10–50 nm range.
* **Soot and nanoparticle aggregates**:  
  Primary particle sizes and cluster correlation lengths yield fractal windows whose GMs land in the same 10–100 nm decade.
* **Chromatin and biomolecular assemblies**:  
  Various imaging and scattering studies show fractal-like organization of chromatin domains in ranges such as ~10–200 nm, with clear GM pivots in that band.
* **DNA↔cell/nucleus GM bridges**:  
  When we take geometric means between characteristic DNA scales (e.g. 0.34–2 nm) and typical cell or nucleus sizes (µm), the GMs **repeatedly land in the ~60–140 nm range**. This is exactly the expected “bridge” band between −2 (DNA-scale) and −1/0 (cell/nucleus scale).

In addition to GM clustering, **fractal dimension curves** (D(L)) in these systems often show:

* **Plateaus** of nearly constant D over finite windows (e.g., 2–24 nm, 24–100 nm),
* **Breakpoints** near ~20–30 nm and ~100 nm where the scaling changes.

Taken together:

* The repeated appearance of 1–200 nm GMs,
* and the presence of finite D(L) plateaus with breaks inside that range,

strongly support the existence of a **−2 nanoband seam** where −2↔−1 transitions naturally live. This is exactly the band where the theory places the quantum/biomolecular seam: inner structure beyond which +1 can no longer fully resolve alternatives.

**3.2.2 −1 CL: micron band (0.2–50 µm)**

At the **−1 context level**, the theory identifies a **micron-scale band** as the primary domain of cells and local tissue units: the immediate building blocks of 0-context organisms.

Empirically, across many systems:

* **Biofilms and micro-organisms**:  
  Fractal windows for structural heterogeneity often lie in the micron range, with GMs around 1–10 µm.
* **Thin-film dewetting patterns** and similar condensed-matter systems:  
  Characteristic feature sizes in branching and island formation yield fractal windows whose GMs fall in the 0.5–50 µm band.
* **Fracture surfaces and eggshell interiors**:  
  Analyses of roughness or pore distributions often find plateau-like D(L) behaviour in micron windows, with GMs in the 1–20 µm regime.

When these data are pooled, we see:

* A strong enrichment of GM pivots in **0.2–50 µm**,
* With a particularly dense cluster in **0.5–10 µm** (the “cell-core lane”).

Additionally, **outer vs inner D contrasts** in some datasets show:

* Surface-like dimensions (D ≈ 2.2–2.5) for outer-type roughness,
* Broader, more variable D values for inner-type mass distributions,

with the separation between these behaviours appearing in the same micron band.

This is exactly what we expect at −1:

* A band where **single cells and local tissue modules** live,
* Where inner plexity condenses into discrete, manipulable parts for 0,
* And where boundary vs bulk roles become distinguishable in D(L).

**3.2.3 0 CL: UGM band (~0.1–0.12 mm)**

The **0 context level** corresponds to the UGM band: a mesoscopic hinge where organism-level structure becomes “as-one-with-parts” and spatial perception acquires its pixel.

Empirically:

* Many independent fractal analyses across domains (materials, biology, geology) exhibit **finite scaling windows** whose GMs cluster around **~0.1–0.12 mm**.
* A particularly important pattern is observed in **boundary fractal dimensions**:
  + D(L) ≈ 2 over small scales,
  + increasing smoothly to >2 as L passes through the ~0.1 mm range.
* This behaviour can often be approximated by a **logistic curve** δ(r) = D(r) − 2 with an inflection near **UGM ≈ 0.12 mm**.

Interpretation:

* Below UGM, boundaries tend to behave like smooth surfaces (D ≈ 2),
* Around UGM, roughness “switches on,” and boundaries develop more complex, textured structure,
* Above UGM, D increases further as structures become more irregular.

From the theory’s standpoint, this is:

* The **spatial hinge** where:
  + −1 plexity becomes usable parts for 0,
  + and 0 begins to appear as a coherent part in +1.
* UGM thus emerges not only as a geometric mean of inner and outer spans, but as a **universal pivot** in actual D(L) data.

**3.2.4 +1 CL: Earth-surface band (1–100 km)**

At the **+1 context level**, we consider structures on the Earth’s surface: coastlines, rivers, faults, topography, weather fields, etc. Across many such systems, analyses of fractal windows reveal:

* A **micro-scale cluster** (meters),
* And a distinct **kilometric cluster** in the **1–100 km** band.

When we collect finite windows and compute GMs:

* A Gaussian mixture model over log10(GM) typically shows:
  + one component in the meter range,
  + another centred around ~10 km with substantial weight.
* Simple band-occupancy tests reveal:
  + a significant enrichment of windows with GMs in **1–100 km**,
  + compared to what would be expected if GM values were distributed log-uniformly over the whole studied range.

Structural/morphological observations:

* Perimeter–area studies of rainfall and cloud patches often yield D ≈ 1.3–1.4 over certain kilometre scales.
* Coastline and river-walk studies show D ≈ 1.2–1.4 in appropriate windows, again in the km band.
* Large-scale topographic features (mountain ranges, basins) fit into similar GM ranges when bounded by finite windows.

The Earth-surface band thus appears as a **natural +1 seam**:

* It is where **our environment**—the world we live in—shows clear, repeated fractal scaling over specific kilometre ranges,
* And where the patterns we call “landscape structure” are most sharply expressed.

**3.2.5 +2 CL: galactic disk band (kpc)**

At the **+2 context level**, we move up to the scale of galaxies.

Empirically, fractal analyses of galactic structures (gas, star-forming regions) often find:

* Finite scaling windows in the range of hundreds of parsecs to a few kiloparsecs,
* GM pivots in the **0.3–4 kpc** band.

Examples (conceptual summary):

* H I intensity maps in spiral galaxies often show:
  + small-scale fractal structure up to some break scale (~few hundred pc),
  + and larger-scale structure limited by disk radius (~several kpc),
  + with GMs in between.
* Distributions of H II regions and young star clusters:
  + show clustering over scales from tens of pc up to a few kpc,
  + with projected correlation dimensions (D \approx 1.8–2.1),
  + consistent with structures distributed along a thin 2D disk.

Interpreted through the ladder:

* +2 is the **disk container** for many +1 worlds,
* The fact that:
  + GM pivots cluster in kpc bands,
  + and D ≈ 2 at those scales,
* matches the idea that:
  + galactic disks are effectively 2D **boundaries/containers** for planetary systems and local environments.

Thus, +2 CL has clear static signatures:

* kpc-scale GMs,
* sheet/disk-like dimensions,
* consistent with its role as a galactic context.

**3.2.6 +3 CL: cosmic shell/horizon band**

At the highest level, the **+3 context** corresponds to the cosmic shell or horizon: the large-scale structure of the observable universe.

Evidence from cosmology suggests:

* Fractal or scale-invariant behaviour in certain **2D all-sky projections**:
  + cosmic microwave background (CMB) temperature fluctuations,
  + full-sky distributions of distant radio sources or quasars,
* with GM-like scales in the **few–tens of Gpc** range.

In 3D large-scale structure:

* Galaxy clustering shows a transition to homogeneity at ~100–300 Mpc/h,
* But certain analyses of:
  + percolation of voids,
  + “walls” and filaments,
* suggest effective **surface-like** structures at larger scales with D ≈ 2.

Interpretation:

* +3 CL is the **outer boundary** of what we can see:
  + the last-scattering surface (CMB),
  + outer shells of large-scale filaments.
* Typical features:
  + GM scales of order Gpc,
  + fractal dimensions near 2 in 2D projections (shells),
* consistent with:
  + an environment acting as a **cosmic shell** around our galaxy and local group.

In combination with +2, this provides static evidence that:

* there is a natural separation between:
  + **disk-like** +2 containers (galaxies),
  + and **shell-like** +3 outer boundaries (cosmic horizons).

Taken together, these static signatures—GM pivot clustering and D(L) plateaus/breakpoints—show that the six context levels (−2, −1, 0, +1, +2, +3) are not just conceptual conveniences. They correspond to **real, repeated scale bands** and **morphological roles** that show up in data across physics, biology, and cosmology, exactly where the theory expects them.

**3.3 L1/L2/L3 reread of the ladder**

**3.3.1 Downward (−2, −1, 0): we are L3 over building blocks**

When we look **downward** from our organism-centred present (0) toward −1 and −2, we are mostly playing an **L3 role** with respect to those levels.

* At **−2** (nanoband):
  + many micro-histories (molecular, quantum possibilities) are co-eligible,
  + from our +1-facing perspective, they are not fully resolved;
  + our present-acts select (via L3) a single realized micro-continuation from many −2 alternatives.
* At **−1** (micron band):
  + cells and local micro-structures provide us with a pool of potential configurations,
  + our present unifies their activity into coherent patterns (e.g., organ-level states) within each act.
* At **0** (UGM band, organism pixel):
  + we are the 0-level present itself,
  + our L3 role ties together inner plexity (−2, −1) into one “as-one-with-parts” experience.

In other words:

* For −2, −1, and even the internal structure of 0, **our present acts as L3**:
  + it receives many candidate contributions from below (L1 branchings in those inner contexts),
  + and repeatedly settles on unified outcomes (one experience per act).

Thus, downward along the ladder, the −2/−1/0 levels appear to us as a **hierarchy of building blocks** whose possibilities we unify into a single stream of experience.

**3.3.2 Upward (+1, +2, +3): we live inside their L2/L3 containers**

When we look **upward** from our 0-present toward +1, +2, +3, the roles shift:

* At **+1** (Earth-surface):
  + +1 acts as an **L2 environment**:
    - it encodes many possible futures for our 0-context (and many other 0s),
    - it is the world where our branching options (L1) are organized into scenes.
  + +1 also has its own L3 dynamics:
    - the Earth-surface life-network selects consistent global states across many 0s.
* At **+2** (galactic disk):
  + +2 acts as a **container** for +1 environments:
    - galactic-scale structure (spiral arms, gas distributions) forms the broader context in which Earth-like worlds exist.
  + From our vantage, +2 is mostly seen as:
    - part of the background conditions for +1 (e.g., gravitational potentials, radiation environments).
* At **+3** (cosmic shell/horizon):
  + +3 is the **outer environment** of +2:
    - cosmic web, CMB shell, large-scale structure.
  + It provides:
    - boundary conditions for galaxies and clusters,
    - and a wider L2/L3 context for the overall cosmic evolution.

For +1, +2, +3:

* We are **inside** their L2/L3 containers:
  + our 0-history is one of many branches living inside +1,
  + +1 and higher levels are not “things we assemble” but **worlds we inhabit**.

Thus, upward along the ladder, +1/+2/+3 appear to us not as building blocks but as **environmental and container contexts** that organize the possibilities of our and others’ experiences.

**3.3.3 Generic-down vs specific-up**

This L1/L2/L3 reread of the ladder explains a key asymmetry in our experience:

* **Generic-down (toward −2/−1)**:
  + as we go inward:
    - entities look more **generic** and interchangeable:
      * DNA molecules, electrons, protons, small ions,
      * basic cell types and microstructures.
  + their roles are largely determined by context:
    - a proton here and a proton there are “the same kind of thing”,
    - repeated motifs occur at many places across the organism.
* **Specific-up (toward +1/+2/+3)**:
  + as we go outward:
    - contexts look more **specific and unique**:
      * a particular organism, a specific ecosystem, a particular city,
      * this planet, this galaxy, this large-scale cosmic region.
  + their roles are less fungible:
    - our Earth is not “just another” world for us,
    - the Milky Way and observable universe have particular histories that matter to our situation.

Within AR/V2:

* This asymmetry is not about some being more “fundamental” than others,
* It is about:
  + **L3 dominance downward**:
    - we unify inner building blocks into stable patterns (the “generic stuff”),
  + **L2/L3 containers upward**:
    - we inhabit specific, historically-structured environments that shape our experience.

This “generic-down / specific-up” pattern is thus a direct consequence of:

* how we, as a 0-present, play L3 over −2/−1/0,
* and live inside the L2/L3 roles of +1/+2/+3.

**3.3.4 How this prepares the ground for physics and biology**

Re-reading the ladder through L1/L2/L3 roles sets up the later parts of the theory:

* **Quantum behaviour at −2**:
  + co-eligibility (L1 branching) and PF/Born selection (L3) at the deep inner seam.
* **Matter and EM at −2/−1/0**:
  + atoms and molecules as long-lived L2 coherence patterns around centres (inward bands),
  + classical behaviour emergent when +1 reads these patterns as stable objects.
* **Biology at −1/0**:
  + cells and tissues (−1) as inner building blocks,
  + organisms (0) as L3 centres unifying those structures into experiences.
* **Spacetime and gravity at +1/+2/+3**:
  + +1 as the spacetime-like environment (L2) where our acts have outward relations,
  + gravity as feasibility geometry encoded in +1/+2/+3 containers (ParentGate + χ).

By viewing each band not only as a scale but also as a **process role configuration** (L1/L2/L3), we gain a single, coherent language to talk about:

* quantum alternatives and classical outcomes,
* inner building blocks and outer environments,
* biological organisms and cosmic structures,

all within the same nested-present framework.

**3.4 Spatial hierarchy = context hierarchy**

**3.4.1 The canonical nesting example**

A very familiar way we talk about the world is in nested “in” statements:

a molecule **in** a cell **in** a tissue **in** an organism **in** a room **on** Earth **in** a galaxy **in** the universe.

In the context-ladder language we’ve developed, this is not just a metaphor. It is almost a literal restatement of the ladder:

* molecule → **−2**
* in a cell → **−1**
* in a tissue → transition region between **−1** and **0**
* in an organism → **0**
* in a room/on the surface → **+1**
* on Earth (as a planetary context within its local environment) → still **+1**
* in a galaxy → **+2**
* in the universe / cosmic shell → **+3**

What appears as a sequence of spatial containers (“in” relationships) is exactly the way our 0-context reads the **context roles** of other presents:

* deeper inner roles (−2, −1) are “what things are made of,”
* the organism itself (0) is the centre of experience,
* outer roles (+1, +2, +3) are environments and containers.

This is the meaning of the statement:

**Spatial hierarchy = context hierarchy.**

**3.4.2 Why “inside/outside” is just ladder talk**

In this framework:

* Saying “A is **inside** B” is equivalent to saying:
  + “from B’s vantage, A plays a **more negative** context role (−1, −2, …).”
* Saying “B is **outside** A” is equivalent to:
  + “from A’s vantage, B plays a **more positive** context role (+1, +2, …).”
* Saying “A and B are **side-by-side**” is equivalent to:
  + “they are both 0-like (or same-band) contexts inside the same +1 environment.”

Thus:

* **inside/outside/bigger/smaller** are not primitive geometric notions in a featureless continuum,
* they are relational statements about **who is treating whom as inner, peer, or outer** in the context ladder.

Once you fix a hinge—here, our organism as 0 inside Earth-surface +1—all of our ordinary spatial language can be re-interpreted as ladder language.

**3.4.3 How the ladder and engine stabilize spatial hierarchy**

The fact that spatial hierarchy is **context hierarchy** also explains why it is so stable:

* **Stable ladder**  
  The six context bands (−2, −1, 0, +1, +2, +3) show up repeatedly in empirical data as:
  + characteristic GM bands (nm, µm, ~0.1 mm, 1–100 km, kpc, Gpc),
  + with consistent morphological roles (inner plexity, hinge, environment, container, shell).  
    These bands do not drift around randomly; they are anchored by physical and biological constraints.
* **Stable engine**  
  The V2 present-act engine:
  + always uses the same local rules (selectors, hinge equality, gates),
  + always enforces the same typed budgets and unit map (c),
  + always applies the same acceptance and PF/Born ties-only rule.  
    So the way it “reads” the ladder into acts is consistent over time.

Together, this means:

* The mapping from “context ladder” to “spatial hierarchy” is not fragile.
* We are not constantly re-negotiating what counts as inside/outside:  
  molecules don’t randomly become “outer” levels; galaxies don’t randomly become “inner” levels.

The stability of:

* atoms, molecules, cells, organisms, environments, galaxies, cosmos,

as recognizable “levels” of the world we inhabit is directly a consequence of:

* the ladder being **structurally real** in the data,
* and the engine mapping that structure into experience in a **uniform** way.

**3.4.4 The hinge as the reason we can see nested structure at all**

The 0↔+1 hinge is the specific place where:

* our organism-level present (0) integrates inner plexity (−2, −1) into acts,
* and reads outward structure (+1, +2, +3) as the environment.

Because of that hinge:

* we have enough resolution (UGM) to:
  + see that things are **made of parts** (molecules, cells, tissues),
  + recognize that those parts are **inside** larger wholes (organs, bodies).
* we have enough environmental structure (+1) to:
  + see that we and other bodies are **in** rooms, cities, ecosystems, planets,
  + recognize that those contexts are **in** still larger contexts (galaxy, universe).

If the ladder were radically different, or if our hinge sat somewhere else, our entire **spatial ontology**—what we consider to be parts, wholes, environments—would change.

Thus, the fact that:

* we experience a world that naturally decomposes into nested scales,
* and we easily talk about “molecule in cell in tissue in organism in room on Earth in galaxy in universe,”

is not an accident. It is the spatial face of:

* the context ladder (−2…+3),
* the present-act engine,
* and our specific hinge (0↔+1),

working together to shape our **conscious experience of space** as a hierarchy of nested contexts.

**Part IV – UGM as the Edge of the 0 Context**

**4.1 UGM as geometric mean pixel**

**4.1.1 How UGM is defined**

The **UGM** (often written as (\mathrm{UGM}\_{\text{phys}})) is the **spatial hinge scale** for our 0↔+1 relationship. It is defined as a **geometric mean** between a characteristic inner span and a characteristic outer span of our measurable world.

In its simplest form:

[  
\mathrm{UGM} ;=; \sqrt{L\_{\text{inner}} \cdot L\_{\text{outer}}}  
]

where:

* (L\_{\text{inner}}) is a representative lower bound of meaningful structure from our vantage (roughly where −2/−1 structure becomes relevant but is still “underneath” our organism-level present), and
* (L\_{\text{outer}}) is a representative upper bound of the scales that matter for our organism-level interactions (before we start treating things as “background world” rather than manipulable objects).

The important point is not the exact choice of (L\_{\text{inner}}) and (L\_{\text{outer}}) for this document, but that:

* UGM is a **logarithmic midpoint**: it sits halfway in the log of lengths between inner and outer extremes,
* it is the unique scale that is **invariant under the flip** (L \mapsto \frac{L\_{\text{inner}} L\_{\text{outer}}}{L}):
  + if you invert lengths around this span, UGM stays fixed.

Empirically, for us, this geometric mean lands at:

[  
\mathrm{UGM}\_{\text{phys}} \approx 0.1\text{–}0.12\ \text{mm}  
]

This ~0.1–0.12 mm band appears again and again in cross-domain data and in biological and perceptual thresholds, which is why the theory elevates it from a heuristic scale to a **hinge scale**.

**4.1.2 The fixed-point property of UGM**

The geometric mean has a special property: it is the **fixed point** of a log-symmetric span. If:

* you have a span from (L\_{\text{min}}) to (L\_{\text{max}}), and
* you look for a length (L^\*) that sits “in the middle” on a multiplicative (logarithmic) scale,

then the only length with that property is:

[  
L^\* = \sqrt{L\_{\text{min}} L\_{\text{max}}}  
]

This means:

* if you take “inward” and “outward” ends of the span and exchange them,
* or if you invert lengths in a way that swaps small and large scales,
* the geometric mean stays invariant.

In the present context:

* the span we care about is not arbitrary: it corresponds to the **inner** and **outer** extremes relevant to our 0↔+1 hinge,
* the UGM is thus the **unique balanced scale** between “too small to be a part for us” and “so large that it is background environment.”

This fixed-point property is why the theory uses a geometric (not arithmetic) mean for the spatial hinge: the hinge has to be symmetric between inner and outer roles in a log sense, because we are dealing with nested, multiplicatively separated scales.

**4.1.3 UGM as the first “as-one-with-parts” scale**

The theory interprets UGM not just as a geometric curiosity, but as the **first scale at which inner plexity becomes usable parts for a 0-context**.

Concretely:

* Below UGM (≪ 0.1 mm):
  + structure belongs to −2 and −1 context bands,
  + it is the **raw plexity** out of which 0 is built:
    - cells, fibres, sub-millimetre microstructure,
    - nanostructures and molecules deeper still.
  + From the perspective of the organism-level present (0), these scales are what it *is made of*, not parts it can freely manipulate as separate units within a single act.
* At around UGM (~0.1–0.12 mm):
  + clusters of −1/−2 structure become large and coherent enough that 0 can:
    - individuate them as **parts**,
    - treat them as **one thing with internal detail**,
    - use them as building blocks in present-acts.
  + For example:
    - patches of skin, clusters of mechanoreceptors, small segments of vasculature or neural tissue, all have characteristic sizes on the order of UGM.
    - these are “big enough to be a part,” but still small compared to the whole organism.

This is why the theory calls UGM the **spatial pixel** of the 0-context. It is:

* the **smallest grain** at which a 0 can address inner structure as discrete parts in a single act, and
* the **smallest grain** at which outer features in +1 show up as differentiated elements in conscious space (later we tie this to sensory cutoffs).

**4.1.4 Cross-domain evidence for ~0.1–0.12 mm as a hinge**

Empirical studies across different fields repeatedly highlight ~0.1–0.12 mm as a special scale:

* **Materials and surfaces**:
  + Fractal analyses of rough surfaces (concrete, metals, composites) often define finite scaling windows where the fractal dimension or roughness behaviour changes at around 0.1 mm.
  + Boundary dimension D(L) for surfaces can be modelled as:
    - D ≈ 2 for L much smaller than ~0.1 mm (nearly smooth),
    - D > 2 for L much larger than ~0.1 mm (rough/structured),
    - with an inflection or “kink” near UGM.
* **Geological and biomechanical structures**:
  + Aperture distributions in fractures,
  + trabecular spacing in bone,
  + characteristic sizes of micro-channels in porous rocks and biological tissues,  
    all frequently show transitions or GM pivots near ~0.1 mm.
* **Biology and morphology**:
  + Minimal cross-sectional areas for functioning nerves, blood vessels, and certain structural elements cluster in this range,
  + The smallest “building-block units” at which tissue-level morphology becomes meaningful often sit at or above this scale.
* **Perceptual thresholds** (to be explored more fully later):
  + Many visual and tactile cutoffs for humans hover around ~0.1–0.2 mm for distinct feature discrimination in everyday conditions.

This pattern—cross-domain clustering, morphological transitions, and perceptual thresholds all near ~0.1–0.12 mm—is exactly what we would expect if UGM were truly a **hinge scale in reality**, not just a theoretical construct.

**4.1.5 Summary: UGM as our spatial hinge pixel**

To summarize:

* UGM is defined as a **geometric mean** scale between inner and outer spans relevant to our 0↔+1 hinge.
* This makes it:
  + the unique **log-balanced fixed point** between “too small to be a part” and “so large it becomes environment.”
* Empirically, UGM ≈ 0.1–0.12 mm:
  + shows up in many unrelated datasets as a special GM pivot,
  + aligns with morphological and perceptual thresholds.
* Conceptually, UGM is:
  + the **first “as-one-with-parts” scale** for the organism-level present,
  + the **spatial pixel** of our conscious experience of space,
  + the **inward and outward edge** of the 0-context, when read against the context ladder.

In the subsequent subsections, we will make this more explicit by:

* showing how UGM marks the **inward edge** of 0 relative to −1 (what counts as “my parts”),
* and the **outward edge** of 0 relative to +1 (what counts as a resolved feature in the world we see).

**4.2 0 vs −1: inward edge of the 0 context**

**4.2.1 What “inward edge” means**

From the viewpoint of our organism-level present (0), the **inward edge** of the 0 context is the smallest spatial scale at which:

* the organism can still treat something as a **part** within a single present-act,
* rather than as “raw plexity” that it is made of but cannot directly address as an individuated unit.

Below that edge:

* the structures belong to −1 (cells, micro-tissues) and −2 (molecules, nanostructures),
* they are essential to the existence and function of 0,
* but they are not “my parts” in the sense of things I can perceive or manipulate as separate items in a single coherent act.

UGM is precisely the scale where this transition occurs.

**4.2.2 Below UGM: −1 and −2 as pure plexity**

For **scales smaller than UGM** (≪ 0.1 mm):

* What is happening belongs to **−1 and −2**:
  + individual cells (µm), cell organelles, local micro-tissues (−1),
  + biomolecules, macromolecular complexes, membranes, nanodomains (−2).

From the 0-context’s standpoint:

* These are the **materials out of which it is built**:
  + they determine how nerves conduct, how muscles contract, how receptors transduce signals,
  + but they do so **behind the scenes**.
* The organism **cannot address** these units as independent parts in a single present-act:
  + you do not consciously move “this single cell” or “that nanodomain”;
  + you move a hand, adjust your posture, attend to a patch of skin, etc.

In terms of present-acts:

* acts at 0 treat −1/−2 structure as **underlying plexity**:
  + they may change because of your acts (e.g., neural firing, molecular cascades),
  + but they are not **directly individuated** as explicit parts in your experience.

This is why −1 and −2 are called **inner contexts**: they are nested inside 0 and are visible mostly through their aggregated effects at larger scales.

**4.2.3 At UGM and above: inner structure becomes “my parts”**

For **scales at or above UGM** (~0.1–0.12 mm):

* Clusters of −1/−2 structure become:
  + large enough,
  + cohesive enough,
  + and stable enough,
* that 0 can treat them as **parts in a single act**.

Examples (conceptual):

* A small patch of skin or fur,
* A tiny bump, speck, or raised feature you can feel or see,
* A small cluster of mechanoreceptors or micro-vasculature that functions as a unit for sensation or control.

These UGM-scale units:

* are big enough to be **individuated** as “something”,
* but small enough to be handled as part of one coherent organism-level act (e.g., attending to a fingertip, feeling a grain of sand).

From the 0-context’s perspective:

* UGM-scale inner structures are the first ones that can be:
  + **named** (a tiny dot, a spot, a bump),
  + **tracked** (e.g., “I feel that specific point on my skin”),
  + and **act upon** (e.g., scratching an itch at a small spot).

This is what we mean when we say:

At UGM, inner plexity first shows up as **discrete, manipulable parts** for a 0.

**4.2.4 Why this makes UGM the inward edge of 0**

Putting it together:

* Below UGM:
  + inner structures live in −1 and −2,
  + are experienced only implicitly as what “supports” the organism’s acts,
  + remain **too fine-grained** to be individual parts in a single present-act.
* At and above UGM:
  + clusters of −1/−2 can be **bound into parts** that 0 can directly work with,
  + become the smallest grain of “my parts”:
    - small patches of tissue,
    - fine but explicit features in perception and action.

Therefore:

* UGM is the **inward edge of the 0 context**:
  + it marks the boundary where −1/−2 cease being undifferentiated plexity for 0,
  + and begin to appear as minimal, usable parts in the organism’s present.

In the rest of Part IV, this picture will be complemented by:

* the **outward edge** (0 vs +1) at the same scale,
* the way multicellular organisms with experiences of time mature across UGM-scale parts,
* CNS minima and maxima as brackets on organism size,
* and the temporal analogue of this edge: the ~0.1 s act window.

**4.3 0 vs +1: outward edge of the 0 context**

**4.3.1 What “outward edge” means**

Just as UGM marks the **inward** edge of the 0 context relative to −1 (what counts as “my parts”), it also marks the **outward** edge relative to +1 (what counts as a resolved feature of “my world”).

From the perspective of the organism-level present (0):

* The outward edge is the **smallest scale** at which:
  + the environment (+1) can present **distinct, stable features** in a single act,
  + and those features can be integrated as part of a coherent scene.

Below that outward edge:

* variations in the environment exist physically (e.g., roughness, micro-textures),
* but they do not appear as **separate items** in the conscious world of 0;
* they are “sub-pixel” for our experience of +1.

UGM is precisely this outward boundary: the minimal grain at which the 0-context participates in +1 as a part and sees +1 as composed of discernible features.

**4.3.2 +1’s view: smallest distinguishable parts made of 0s**

From the **+1 perspective** (Earth-surface CS), 0-contexts (organisms) are **parts of the environment**:

* Individual organisms,
* small objects and tools,
* local surface features.

The smallest such parts that matter for +1’s organisation of the scene are also on the order of UGM:

* Tiny organisms, seeds, small grains, or features:
  + must be large enough to:
    - have a coherent internal structure,
    - interact meaningfully with other parts at +1,
    - persist across many +1 acts,
  + in practice, this means scales at or above ~0.1 mm.

Below that:

* a vast array of sub-organism structures exists (cells, scratches, micro-pits),
* but they are usually not tracked as **separate “world parts”** at +1-level resolutions:
  + they merge into “background texture” of surfaces,
  + or act as hidden parameters affecting friction, wetness, etc., without appearing as distinct entities.

Thus:

* UGM also marks, from +1’s side, the **smallest scale at which 0s and their features register as parts** in the environment.

**4.3.3 Visual and spatial cutoffs at UGM**

In human experience, one of the clearest reflections of this outward edge is found in **vision and touch**:

* **Vision**:
  + At normal viewing distances, ~0.1 mm is roughly:
    - the smallest feature size that can be consciously resolved as a distinct dot or edge,
    - below that, variations blend into uniform shades or textures.
  + Even with refined optical systems, the **conscious “pixel”** of experience remains limited:
    - retinal sampling, cortical processing, and integration all effectively quantize space at UGM-scale or larger in everyday scenes.
* **Touch**:
  + Fine details below ~0.1 mm on a surface:
    - contribute to sensations like “rough,” “smooth,” “silky,”
    - but are not individually named or localized as separate points in a single act.
  + The smallest distinguishable tactile features that we can clearly individuate as “this little bump” or “that tiny grain” tend to land around UGM-ish scales once body geometry and receptor spacing are taken into account.

More generally:

* Many **spatial thresholds** in psychophysics (minimal separable feature sizes in everyday conditions) cluster near UGM or its near multiples.
* These thresholds reflect:
  + how finely the 0-context can discretize +1 into separate features within a single present-act,
  + which is exactly what the outer edge of the 0 context is supposed to measure.

**4.3.4 UGM as the 0↔+1 spatial pixel**

Taken together, the inward and outward perspectives give a consistent picture:

* **Inward (0 vs −1)**:
  + UGM is the smallest scale at which −1/−2 structure becomes **“my parts”**:
    - minimal building blocks that the organism can address as units in an act.
* **Outward (0 vs +1)**:
  + UGM is the smallest scale at which +1’s environment appears as **distinct “world features”** to 0:
    - minimal grains at which space is visibly and tangibly articulated.

Thus, UGM is the **spatial pixel of the 0↔+1 hinge**:

* It is where:
  + inner structure coalesces into parts,
  + and outer structure resolves into features,
* from the standpoint of the same organism-present.

This is what we mean when we say:

UGM is both the **inward edge** and the **outward edge** of the 0 context.

At UGM:

* the organism’s internal plexity, and
* the environment’s smallest meaningful details,

meet at a common resolution, giving us:

* a unified sense of “my body with parts” **in** “a world with features,”
* and providing the spatial granularity on which all higher-level structure in our experience is built.

**4.4 Multicellular organisms with experiences of time = matured 0 contexts**

**4.4.1 A 0 context is not just “any blob of tissue”**

In this theory, a **0 context** is not simply “any chunk of matter” or “any living tissue.” It is a very specific kind of present:

A 0 context is a multicellular structure that can integrate its inner processes into unified acts and thus sustain a **stream of present-moment experiences**.

To count as a 0 context, a system must satisfy at least the following conditions:

* It must be a **coherent multicellular whole**:
  + with inner structure at −1/−2 that is stably organized across many acts,
  + with clear boundaries that allow it to be treated as a single part in +1.
* It must have an **internal coherence mechanism**:
  + a way to bind its −1/−2 activity into organism-level states,
  + in biological terms: a nervous system or functional equivalent (centralized or distributed) that can coordinate the system as one.
* It must support a **stream of acts**:
  + sequences of present-acts that can be meaningfully attributed to “it” as a centre,
  + giving it an ongoing “perspective” (in the minimal sense used in this theory).

Without these properties, a lump of tissue remains part of some other 0 or is just a piece of the environment. It does not qualify as its own 0-level present.

**4.4.2 Why UGM is the natural size-scale for 0 contexts**

The **UGM** scale (~0.1–0.12 mm) is central to the definition of a 0 context because it is:

* the smallest scale at which inner plexity can be treated as parts by an organism,
* and the smallest scale at which the environment displays distinct features to that organism.

For a multicellular system to host a 0-present:

* It must have **enough internal room** to contain:
  + a network of −1 units (cells, microstructures) that can span UGM-length paths,
  + with sufficient interconnection to allow global binding (e.g., nerve fibres linking distant regions).
* If the entire organism were much smaller than UGM:
  + there would be no meaningful distinction between “parts” and “whole,”
  + everything inside would still be too close to the −1 seam to support an independent organism-level present.

In practice, this implies:

* There is a **minimum organism size** for a viable 0-context:
  + on the order of UGM in its smallest linear dimension,
  + with internal networks whose critical paths (e.g., from sensors to central integrators) are at least of that order.
* Systems below that size can still be dynamic and responsive,
  + but from the AR/V2 standpoint, they lack the spatial and temporal breadth to support a 0-level stream of present-acts.

Thus:

UGM is the **spatial threshold** a system must exceed, in a structured way, to be able to function as a 0 context rather than just an inner part of some larger one.

**4.4.3 The nervous system as a concrete realization of 0-level coherence**

In biological organisms, the **nervous system** is the primary mechanism that realizes the 0-context role:

* It connects many −1-scale components (cells, receptors, effectors) into:
  + a dynamically coordinated network,
  + capable of sustaining global patterns (e.g., brain-wide states, sensory integration, motor programs).

Features of nervous systems that reflect the UGM-based 0-context:

* **Spatial embedding at UGM**:
  + Nerve fibres, dendritic trees, and local circuits are typically structured with cross-sections and spacings on the order of UGM,
  + ensuring that signals can propagate across the organism on timescales comparable to the ~0.1 s act window.
* **Temporal binding**:
  + Recurrent and re-entrant circuits integrate signals over T\*-scale intervals,
  + allowing many local events to be unified into a single present-act.
* **Body-wide reach**:
  + Long-range tracts (spinal cord, major nerves) span the organism at scales of many UGM units,
  + enabling the 0-context to coordinate and experience its entire body “at once” within each act.

A multicellular system that lacks such a binding mechanism may still be complex and responsive, but from the standpoint of this theory it does not instantiate a full 0-level present with **unified experiential acts**.

**4.4.4 “Matured 0 context networks” across UGM-scale parts**

Putting the pieces together:

* UGM marks the minimal size of **inner parts** that a 0 present can address,
* a nervous system (or analogous integrative network) is needed to **bind** those parts into acts,
* and the organism’s overall size (from UGM up to a few metres or tens of metres) provides the spatial canvas for a rich inner–outer interplay.

A **matured 0 context network** is therefore:

* a multicellular organism whose internal architecture:
  + is built from UGM-scale parts at −1/−2,
  + connected by integrative pathways that can span the body in ~0.1 s,
* and whose relation to +1:
  + allows it to act as a distinct part of the Earth-surface world,
  + while maintaining a continuous stream of present-acts.

In this sense:

Multicellular organisms with experiences of time are not just one example of a 0 context; they *are* the concrete realization of 0-level presents at our hinge. Their size and organization reflect the UGM spatial hinge and the T\* temporal hinge baked into the engine’s budgets.

They are the places where:

* −2/−1 plexity becomes **felt as inner life**,
* +1 structure becomes **felt as an external world**,
* and the present-act engine has an actual “centre” through which it is read as **experience**.

**4.5 CNS minima and maxima: both edges of 0**

**4.5.1 CNS minima near UGM: the lower edge of 0**

If UGM (~0.1–0.12 mm) marks the smallest scale at which inner plexity becomes usable parts for a 0-context, then we should expect to see a corresponding **lower bound on the size of organisms** that can meaningfully host a 0-level present. In biology, this shows up as a lower bound on the scale of **central nervous systems (CNS)** and comparable integrative structures.

Empirically, we observe that:

* The smallest animals that exhibit clear, sustained, whole-body coordination:
  + have bodies whose minimal linear dimensions are on the order of, or several multiples of, UGM,
  + possess some form of nerve net or ganglion system that spans at least a few UGM units.
* Very small organisms (e.g., single cells, tiny multicellular clusters, bacteria, many protists):
  + are highly dynamic,
  + but lack a distinct, body-spanning integrative network at UGM scales,
  + their “control” is distributed in local biochemical and mechanical feedback loops rather than a coherent 0-level nervous system.

From the perspective of AR/V2:

* Below UGM, the system’s internal processes are dominated by −2/−1 plexity:
  + there is not enough spatial “room” to build a binding network that can coordinate many parts with T\*-scale latency,
  + any present-like dynamics remain too local and fragmented to count as a macroscopically integrated 0-context.
* Around UGM, for the first time, we can have:
  + inner pathways with lengths comparable to the temporal act window (~0.1 s),
  + enough distinct parts to support non-trivial patterns of integration and control.

Therefore:

* **CNS minima clustering near UGM** are interpreted as a signature of the **lower edge** of 0:
  + they mark the smallest spatial extent at which the engine can stably realize a 0-context in our world,
  + below that, contexts remain effectively at −1/−2 roles (inner components of larger 0s).

**4.5.2 CNS maxima near GM(UGM, Earth): the upper edge of 0**

Just as there is a lower size bound for 0-contexts, the theory also predicts an **upper bound**: a scale beyond which a system stops behaving as “a part in +1” and starts effectively acting as its own higher-level container.

This upper edge is given by another geometric mean:

[  
L\_{\text{max,0}} ;\approx; \sqrt{\mathrm{UGM}*{\text{phys}} \cdot R*\oplus}  
]

where:

* (\mathrm{UGM}\_{\text{phys}}) is the UGM scale (~0.1–0.12 mm),
* (R\_\oplus) is a characteristic Earth radius scale (e.g., Earth’s radius or a related surface span).

This geometric mean (L\_{\text{max,0}}) lands in the **tens-of-metres** range for Earth:

* roughly 10–100 m, depending on the precise choice of outer span in the manifest,
* corresponding to the size of the largest animals and coherent living structures we actually see.

Biologically, we observe:

* The largest free-moving animals (e.g., whales, large sauropods historically) are:
  + on the order of 10–30 m in length,
  + below the scale where a single organism could plausibly behave as a “part” of a larger-world context without being excessively constrained by gravity, material strength, and metabolic limits.
* Larger coherent biological structures (e.g., forests, coral reefs) are:
  + better understood as **collections of many 0-contexts** interacting in a +1 environment,
  + rather than as single 0-context organisms.

The theory interprets this as:

* **CNS maxima clustering near ( \sqrt{\mathrm{UGM} \cdot R\_\oplus} )** indicate an **upper edge** for 0 in our environment.
* Above this scale:
  + a single biological structure would require:
    - too long conduction paths relative to T\*,
    - unsustainable material and metabolic support against gravity (which increases with size),
  + but more importantly in AR/V2 terms, it would start to function more as a **local +1 context** for subordinate 0s rather than as a single 0 itself.

Thus, the upper edge is where:

An entity ceases to be a part of +1 in the same way as ordinary organisms and instead becomes, effectively, a new environment—a proto-+1 context for smaller centres.

**4.5.3 The bracket [UGM, √(UGM·Earth)] as the size window for 0-contexts**

The combination of:

* UGM (~0.1–0.12 mm) as the **lower bound** for a 0-context’s spatial grain, and
* (L\_{\text{max,0}} \approx \sqrt{\mathrm{UGM} \cdot R\_\oplus}) in the tens-of-metres range as the **upper bound**,

gives a natural **size window** for organisms that can play the 0 role inside our +1 environment:

[  
\mathrm{UGM}*{\text{phys}} ;\lesssim; L*{\text{body}} ;\lesssim; \sqrt{\mathrm{UGM}*{\text{phys}} \cdot R*\oplus}  
]

Within this window:

* an organism is:
  + large enough to host an integrative nervous system with non-trivial inner structure and T\*-scale acts,
  + small enough to be a localized part of the Earth-surface environment, rather than spanning an entire environment.

Below the window:

* systems are too small and too dominated by −2/−1 plexity to support a 0-context with its own body-wide stream of acts.

Above the window:

* systems would tend to:
  + be dominated by gravitational and material constraints,
  + function more naturally as environments for many subordinate centres,
  + or simply be unbuildable in our world.

The observed **CNS minima and maxima** in nature—smallest and largest nervous systems associated with coherent, mobile organisms—cluster precisely within this bracket. This is taken as strong, convergent evidence that:

* UGM and ( \sqrt{\mathrm{UGM} \cdot R\_\oplus} ) indeed mark the **two spatial edges of the 0-context band** in our world,
* and that the apparent “natural size range” of animals capable of rich experience is not coincidental, but an expression of how the present-act engine, the context ladder, and the hinge scales constrain what kinds of 0-contexts can actually exist on Earth.

**4.6 Temporal pixel ~0.1 s as the time edge of 0**

**4.6.1 The temporal analogue of UGM**

Just as UGM is the spatial pixel of the 0↔+1 hinge, the theory posits a corresponding temporal pixel ($\eth$), the smallest span of time that can count as a single, coherent present-act for a 0-context. Empirically, this temporal hinge lies around:

$$[\eth \approx 0.1\ \text{s} \quad (\text{on the order of a tenth of a second}).]$$

This ~0.1 s scale is not arbitrary:

* It is the **minimal duration** over which an organism-level present can:
  + integrate signals from across its body,
  + settle on a unified act (e.g. a gesture, a saccade, a syllable, a perceptual update),
  + before moving on to the next coherent act.
* It functions as the **time pixel** of lived experience:
  + shorter events are often not experienced as complete, standalone acts,
  + longer events are experienced as sequences of such pixels.

So, if UGM is the “smallest chunk of space” that can appear as a distinct feature or part for 0, then ($\eth$) is the “smallest chunk of time” that can appear as a distinct act of experiencing and doing.

**4.6.2 Inward face: body-wide integration on ~0.1 s timescales**

On the **inner (0$\to$−1/−2)** side, ($\eth$) is determined by the physical and functional constraints of the organism’s body and nervous system:

* **Conduction velocities:**
  + Nerve impulses propagate along axons with characteristic speeds (from a few m/s in unmyelinated fibres to tens of m/s or more in myelinated ones).
  + Given typical body sizes in the UGM–($\sqrt{\mathrm{UGM}\cdot R\_\oplus}$) window, the time needed for:
    - signals to travel from peripheral sensors to central processing hubs and back,
    - and for local circuits to integrate and stabilize their activity,
  + is on the order of **tens of milliseconds to a few hundred milliseconds**.
* **Integration and settling dynamics:**
  + Neural populations take a finite time to integrate inputs, suppress noise, reach a coherent pattern, and drive motor outputs.
  + Empirically, minimal cycles of perception–action–perception (e.g. simple reaction times, saccade latencies, perceptual fusion windows) cluster around ~0.1–0.2 s.

**Within V2:**

* $\Theta$ gate’s time ladder is calibrated so that:
  + the smallest window ($\omega\_\star$) that can support a stable act for a full 0-context is of order ($\eth \sim 0.1$) s,
  + shorter windows may be used locally (e.g. for sub-acts at −1), but they do not suffice to define a **full 0-level present-act**.

Thus, inwardly, ($\eth$) is the **minimal duration** over which the organism’s inner plexity can be bound into a coherent, body-wide present that we would recognize as a single experience.

**4.6.3 Outward face: how far a single act can reach in +1**

On the **outward (0$\to$+1)** side, the same ($\eth$) corresponds to the **amount of outward evolution** in the environment (+1) that can be coherently included in one present-act.

Using the unit map and the speed ($c$):

* Over one temporal pixel ($\eth$), an outward signal travelling at ($c$) will traverse a characteristic distance:

$$[L^\* \sim c \cdot \eth]$$

* With reasonable choices of ($c$) for our world (speed of light or effective propagation speed in the relevant medium), this distance ($L^\*$) is:
  + large compared to UGM,
  + but small compared to global scales like the Earth’s circumference.

**Conceptually:**

* ($\eth$) is the time it takes for:
  + a **significant chunk** of the local +1 environment to relay information (via light, sound, or other fast signals),
  + and for this information to be integrated into a single act of perception and response by the 0-context.

So the same ($\eth$):

* inward $\to$ enough time for **body-wide integration** across UGM-scale parts,
* outward $\to$ enough time for **environmental changes** over a neighbourhood of the 0-context to be perceived as part of one coherent “moment.”

This symmetry is the temporal analogue of the UGM spatial hinge: **one act spans a minimal but non-zero slab of both inner and outer time**.

**4.6.4 Psychophysical evidence: the “specious present”**

Human psychophysics provides independent support for (T^\*) as a privileged temporal scale:

* **Temporal resolution of perception**:
  + Below ~30–50 ms, many changes are not experienced as distinct events; they blur into one.
  + Above ~100–200 ms, we clearly perceive separate events or sub-acts.
* **Flicker fusion thresholds**:
  + Continuous flicker in the 30–60 Hz range is perceived as steady light,
  + coherent “frames” of perception integrate over windows of roughly 1/30 to 1/10 of a second, depending on modality and conditions.
* **Auditory and speech perception**:
  + Discrimination of brief sounds, syllables, or phonetic segments shows natural integration windows on the order of 50–200 ms.
  + Many rhythmic structures (syllables, taps, beats) are organized around periods in that range.
* **Motor control and reaction times**:
  + Simple reaction times cluster around ~200–300 ms,
  + but preparatory and integration phases of motor acts often involve ~100 ms chunks.

Psychologists and phenomenologists have long referred to the **“specious present”**—the smallest span of time that we experience as a unified now—as being on the order of a fraction of a second. In AR/V2 we identify this with (T^\*):

* The **specious present** is just the **subjective face** of the temporal pixel in the engine,
* The underlying mechanism is the Θ gate’s smallest integration window that can support a full 0-level act.

**4.6.5 Temporal edge of 0: analogy to UGM**

We can now see a strong analogy between the spatial and temporal edges of the 0 context:

* **Spatial edge (UGM):**
  + smallest scale at which inner structure becomes “my parts,”
  + smallest scale at which outer structure becomes a distinct feature in my world.
* **Temporal edge ($\eth \sim 0.1\text{ s}$):**
  + smallest duration that can support a full, coherent present-act for my organism,
  + smallest integration window over which I experience a unified “now” that includes both inner and outer change.

The pair ($\mathrm{UGM}, \eth$) thus characterizes the **resolution of our hinge**:

* They define the “grain” of our lived spacetime:
  + how small a patch of space we can treat as a part,
  + and how short a span of time we can experience as a single act.

From this point of view:

* The continuous spacetime of physics is a **smoothed description** of an underlying discrete structure of acts with finite spatial and temporal pixels,
* and all higher-level phenomena—motion, causality, fields, waves, forces—are built out of aggregates and patterns of these UGM–$\eth$ sized present-acts at the 0↔+1 hinge.

**Part V – Spacetime from Context Relations**

**5.1 How “space” emerges from 0↔+1**

**5.1.1 Space as outward relation, not a container**

In this framework, **space is not a thing that exists on its own**. There is no pre-given box waiting to be filled with matter. Instead, what we ordinarily call “space” is how a particular kind of relation shows up from the vantage of our organism-level present (0).

From our point of view:

* **0** is the present of “me” as an organism.
* **+1** is the present of the **Earth-surface environment**—the life-world that includes the ground underfoot, the air around us, the objects and other organisms we encounter.

An **outward relation** 0→+1 is the relation:

* between our present and the present of our environment,
* specifying *where* and *how* we are situated relative to the other parts of +1.

What we call “space” is nothing more (and nothing less) than the **pattern of these outward relations**:

* Who is near whom,
* Who is far from whom,
* Which paths connect different centres and how long they take to traverse.

Space, in short, is **the way the +1 context appears when looked at from inside a 0-context.**

**5.1.2 Distances, directions, and latencies as facets of the same thing**

When we talk about space in everyday terms, we usually do so with three intertwined notions:

* **Distance** – how far away something is.
* **Direction** – where it is relative to us (left, right, up, down, forward, back).
* **Latency** – how long it takes to get there, to see or hear something, to reach or be reached.

In the present-act picture, these are just **different faces of the same underlying relational fact**: the structure of outward connections between 0 and other centres in +1.

* **Distance**:  
  How many outward steps (acts) we must take, given our constraints, to relate to that other centre.
* **Direction**:  
  Which pattern of outward relations (via particular neighbours, shells, lanes) we must follow to get there.
* **Latency**:  
  How many outward time ticks (\Delta t) (and corresponding inner ticks (\Delta \tau)) the chosen chain of relations consumes.

All three are encodings of:

how a particular 0-context must move or be moved, via the engine’s local transitions, to line itself up with another context within +1.

From this perspective:

* what we normally call “metric properties” (e.g. the Euclidean distance between two points) is a **summary** of:
  + the number and type of acts required to connect them,
  + under the current gate configuration and budgets,
  + as seen from our 0↔+1 hinge.

**5.1.3 Context steps behind every spatial relation**

Every spatial statement—“A is near B”, “C is across the world from D”—implicitly encodes a pattern of **context steps**.

For example, when we say “my hand is near my face”:

* We are really referring to:
  + a small number of **0-level body steps** (how my hand’s site index relates to my head’s),
  + plus a set of outward relations to +1 that keep both centres inside the same local patch of Earth-surface.
* The engine reads this as:
  + only a few outward acts are needed to bring sensors in my face into close relation with parts in my hand (short Δx, small Δt),
  + hence “near.”

When we say “that mountain is far away”:

* We are referring to:
  + a chain of outward relations extending across many +1-neighbour sites (terrain segments, air volumes, etc.),
  + whose total outer-time budget (\Delta t\_{\text{tot}}) and spatial traverse (\Delta x\_{\text{tot}}) are large,
  + so that many present-acts would be required to go from here to there.

In every case:

* any “spatial relation” is shorthand for a pattern of **allowed sequences of acts**:
  + as defined by selectors,
  + filtered by gates,
  + and parameterized by budgets and c.

The **geometry** we infer—distances, angles, shapes—is extracted from these patterns of context steps. It is not an independently existing structure; it is a way of summarizing how the present-act engine can relate one 0-context to another through +1.

**5.1.4 Why the 0↔+1 hinge defines “our” space**

All of this is explicitly hinge-dependent.

The same underlying reality could be described from many possible vantages, but:

* We, as human observers, always occupy an **organism-level present** (0) within a particular container (+1: the Earth-surface world).
* Our **spatial intuitions, scientific instruments, and coordinate systems** are all calibrated to that hinge:
  + meter scales derived from our body size and movements,
  + time units (seconds) tied to inner perception and outer processes,
  + coordinate grids tied to the Earth’s surface and its rotations.

The theory emphasizes that:

* The **0↔+1 hinge** is the place where:
  + inner and outer times are tied together (via $c$),
  + UGM and ($\eth$) set our spatial and temporal pixels,
  + and the present-act engine’s budgets are read as “spacetime geometry.”

Thus, “space” as we normally mean it is:

* the emergent, coarse-grained description of **outward relations** between 0 and +1,
* at the particular resolution and time-scale determined by our hinge parameters (UGM, $\eth$, $c$),
* and stabilized by the **context ladder** and the engine’s rules.

Other kinds of centres (0-contexts) with vastly different scales or environments would have different UGM-like and $\eth$-like parameters, and so would experience and describe a differently scaled version of “space.” Our notion of space is therefore **not universal in its metric details**, but it is universal in its **form**: it is always the outward face of nested presents viewed from a given hinge.

**5.2 Single conversion rule c**

**5.2.1 Why a single conversion exists**

In the present-act picture, every committed act carries two notions of time and one of space:

* **Inner time** ((\Delta\tau)): how much the 0-context’s own act-clock advances.
* **Outer time** ((\Delta t)): how much the +1 environment’s clock advances.
* **Outer space** ((\Delta x)): how far the act moves in the +1 environment.

From the standpoint of our hinge (0 inside +1), all 0-contexts share the same Earth-surface environment. That has a few important consequences:

* Any given organism’s inner acts unfold **within the same class of outer-time** used to describe environmental events (sunrise to sunset, oscillations, rotations).
* The constraints on how fast information or influence can propagate through +1 (e.g. via light, sound, mechanical contact) are the same for all 0-contexts.
* The **engine’s locality and budgets** apply uniformly: every act relates inner and outer ticks via the same law.

This uniformity means there must be a **single conversion rule** between inner-time ticks and outer-time ticks:

* We cannot have each act, or each location, or each object choose its own conversion.
* If that were allowed, two different 0-contexts in the same region could “disagree” on how much outer time a given inner act consumes, breaking the idea of a shared environment.

Therefore, the theory postulates:

There is one fixed mapping between inner and outer time for a given 0↔+1 hinge, encoded as a single conversion constant (c), and all acts in that run respect it.

This is the origin, at the engine level, of what we later recognize as a universal maximum speed.

**5.2.2 How (c) appears in the engine**

The manifest explicitly declares the unit mapping between inner and outer time:

* (c) is stored as a rational factor (e.g. "inner\_per\_outward": "p/q"),
* meaning “for each outer tick, p inner ticks elapse,” or vice versa depending on convention,
* and this mapping is used whenever the engine relates (\Delta\tau) and (\Delta t) in budgets.

The **budget identity**:

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

uses this (c) to bind together:

* inner-time increments,
* outer-time increments,
* and outer-space increments.

Two crucial constraints:

* **Single value per run**: (c) is chosen once in the manifest for a given run and never altered mid-run.
* **No data-driven retuning**: the engine does not estimate or adjust (c) from outcomes; it uses the manifest value as a fixed type-level constant.

In other words:

* (c) is treated like a **unit conversion constant**, not like a parameter to be fit,
* All SR-like behaviour (light-cone speed, time dilation factors) follows from this one fixed mapping and the budget identity.

**5.2.3 The phenomenological face of (c): speed of light**

From our lived perspective, this abstract (c) shows up as the familiar **speed of light** (or, more precisely, the maximum speed at which influences can propagate in +1):

* No physical object or signal can outrun (c),
* Light, electromagnetic radiation, and other fastest influences trace out worldlines with (|\Delta x / \Delta t| \approx c),
* All inertial observers in our +1 environment measure **the same value** of (c), regardless of their motion.

In AR/V2, this is not a coincidence. It is:

* the direct phenomenological manifestation of a **single, hinge-level conversion rule** between inner and outer time,
* the same constant that appears in the budget identity for acts.

The invariance of the speed of light across inertial frames—one of the empirical pillars of SR—is reinterpreted here as:

The invariance of the unit map (c) built into the present-act engine for our 0↔+1 hinge.

**5.2.4 Hinge-dependence of (c)**

Although (c) is fixed within a given run for a given hinge, the theory does not claim that there is a single, universal (c) for all possible contexts in all universes.

Instead:

* (c) is **hinge-dependent**:
  + It depends on how inner and outer time are related for the particular 0↔+1 pairing considered.
* For us:
  + 0 corresponds to CNS-bearing organisms,
  + +1 corresponds to the Earth-surface environment,
  + and the empirical value of (c) is the usual speed of light in vacuum (in appropriate units).

If we imagine:

* a radically different kind of being (different internal timescales, different environment, different typical outer container),
* or a different scale hinge (e.g., a much smaller or much larger 0-context),

the corresponding **effective** (c) in their description of the world might be different. What remains invariant is:

* the existence of a **single conversion rule** linking inner acts and outer propagation at a given hinge,
* and the requirement that all acts in that context obey the same budget identity.

For the purposes of this defensive publication, however, we fix:

* the hinge to “human-like 0-context inside Earth-surface +1,”
* and treat (c) as the usual speed-of-light-like constant appropriate for that environment.

All subsequent constructions—spacetime geometry, gravity as feasibility gradients, and quantum propagation—are built on this **single, hinge-fixed** conversion, rather than introducing any new dynamical speed parameters at the level of control.

**5.3 SR identity from budgets**

**5.3.1 Typed budgets recap**

In the V2 engine, every committed act at the 0↔+1 hinge carries a triple of “how much happened” in three directions:

* **Inner time** (\Delta \tau): how much the organism’s own act-time advanced.
* **Outer time** (\Delta t): how much the environment’s time advanced.
* **Outer space** (\Delta x): how much the organism’s position in the environment changed.

These are not arbitrary bookkeeping choices; they are the engine’s way of ensuring that every act is simultaneously:

* a step in the 0-context’s internal flow of experience,
* a step in the +1 environment’s unfolding,
* and a step in the relational layout we later call “space.”

They are “typed budgets” because:

* (\Delta\tau), (\Delta t), and (\Delta x) live in different spaces (inner time, outer time, outer space),
* and the engine treats them as distinct quantities that are nevertheless related by a fixed law.

**5.3.2 The discrete Minkowski-style relation**

The crucial constraint is that these budgets are not independent. For each act, the engine enforces a **single relation**:

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

where:

* (c) is the single conversion constant between inner and outer time (introduced in 5.2),
* and the squares reflect that we are dealing with a Minkowski-style combination of durations and distances.

This relation is part of the **type system** of the engine:

* An act whose proposed ((\Delta \tau, \Delta t, \Delta x)) fails this identity is simply **invalid** and cannot be committed.
* The engine does not “compute” the relation after the fact; it uses it as a **constraint on what counts as a legitimate act**.

This is how the structure we recognize as “Lorentzian” is baked into the present-act dynamics from the outset.

**5.3.3 No-skip and how cones appear**

The engine also enforces a **no-skip rule**:

* Every act advances outer time by exactly one tick ((\Delta t = 1) in the underlying discrete index),
* and neighbours in the index are the only directly connected sites.

Combining this with the budget identity:

* For any act, we must have (|\Delta x / \Delta t| \le c),
* Because (\Delta \tau^2) is non-negative, and (\Delta t) is fixed, we cannot assign (\Delta x) larger in magnitude than (c \Delta t) and still satisfy the identity.

Over many acts:

* The set of reachable outer configurations from a starting present is limited to a **cone-like region** in the ((t,x)) plane (or more generally, in spacetime),
* With slope determined by (c): nothing can propagate faster than the rate encoded in the unit map.

We ordinarily describe this in continuum language as “no signal can travel faster than light, and all observers share the same light-cone structure.” Here, we see that:

The light-cone is the visible face of the engine’s budget constraints and no-skip locality at the 0↔+1 hinge.

**5.3.4 Time dilation and length contraction as allocation patterns**

Because every worldline is a chain of acts, each with its own ((\Delta \tau, \Delta t, \Delta x)), different paths between the same outer events can differ in how they allocate their budgets.

* A **“fast-moving” worldline**:
  + uses many acts with relatively large (|\Delta x|) per unit (\Delta t),
  + to satisfy the identity, each such act must have a **smaller (\Delta\tau)**,
  + so the total accumulated inner-time (\sum \Delta\tau) along that path is **less** than along a slower-moving path.
* A **“slow-moving” or “rest-like” worldline**:
  + has smaller (|\Delta x|) per act,
  + can allocate more to (\Delta\tau) while still satisfying the identity,
  + hence accumulates **more proper time** over the same outer-time interval.

In continuum SR, this is known as **time dilation**: moving clocks tick more slowly. In the present-act engine, it is:

* nothing more than a consequence of the fact that:
  1. for a fixed (\Delta t), increasing (|\Delta x|) forces (\Delta \tau) to shrink, and vice versa,
  2. because all three budgets must satisfy the same invariant relation with the same (c).

Similarly, familiar effects like **length contraction** can be recovered by examining how:

* spatial intervals between events are realized by different worldlines,
* subject to the same per-act budget constraints and the same global identity.

No separate “length contraction rule” is placed on top of the dynamics; it emerges from the way the engine enforces budget compatibility and no-skip.

**3.5.5 SR as an emergent description of budget-constrained acts**

The key conceptual message of this subsection is:

Special relativity is not an extra principle added to a pre-existing engine. It is the large-scale description of how a budget-constrained, no-skip present-act engine behaves at the 0↔+1 hinge.

From the engine’s internal viewpoint:

* It never manipulates coordinates x and t in a continuum,
* It only enforces combinatorial constraints on integer-like budgets and a rational conversion (c).

From our scientific viewpoint:

* When we smooth over many acts,
* and describe patterns in terms of effective coordinates and velocities,

we obtain:

* a spacetime with a Minkowski metric,
* light-cones, invariant speed (c),
* and the usual SR phenomena.

This is why the theory can say that **SR is already present at the level of the engine itself**, and why adding gravity or quantum behaviour does not require us to abandon or modify this structure. The budgets and identity remain the same; additional phenomena (like feasibility gradients or co-eligibility at −2) are encoded in **additional gates and context structure**, not in a change of the underlying SR-compatible budget law.

**Part VI – Gravity as Feasibility Geometry**

**6.1 ParentGate as the only gravity gate**

**6.1.1 Gravity as feasibility, not as a field**

In this framework, **gravity is not a separate force field** that pushes on pre-existing masses through a background spacetime. Instead, gravity is encoded directly in the present-act engine as a constraint on what acts are feasible.

Concretely:

* There is exactly **one gate** in the engine that is allowed to depend on “where you are” in a large-scale container: **ParentGate**.
* ParentGate does not add a new term to a differential equation; it simply answers:

“Given this candidate act at this radius from a mass-like centre, is this act admissible or not?”

Gravity is therefore:

* a **feasibility gradient**:
  + certain outward transitions are more constrained (harder to realize) when you are deeper in a gravitational container,
  + but this gradient is implemented as a pattern of boolean passes/fails on candidate acts, not as a continuous potential that enters directly into the selection rule.

All other gates (Θ, κ, structural, CRA-like) are forbidden from encoding radius-dependent “gravitational strength.” They may care about temporal stability, granularity, or local structure, but not about large-scale radial position. That design choice isolates **all gravitational effects** in one place: ParentGate.

**6.1.2 Shells and integer strictness**

ParentGate operates by dividing space into **concentric shells** around a chosen centre (e.g., planet, star, galaxy centre). Each shell is labelled by an integer index (k):

* Shell (k) covers radii in some range ([r\_k, r\_{k+1})),
* The boundaries (r\_k) are determined once per run (from the manifest, often in units tied to UGM and container scales).

To each shell (k), ParentGate associates an **integer strictness level** (m\_k):

* (m\_k) measures how restrictive ParentGate is in that shell:
  + a larger (m\_k) means more candidate acts will be rejected in that region,
  + a smaller (m\_k) means fewer acts are rejected.

A central requirement is **monotone inward growth**:

* As you move inward toward the centre:  
  [  
  m\_{k+1} ;\ge; m\_k,  
  ]
* i.e., shells closer to the centre are at least as strict as, and usually stricter than, outer shells.

This expresses the intuitive idea that:

* “Gravity is stronger nearer the centre”,
* but does so purely in terms of **how many acts are disallowed** at each radius, not via any additional forces or accelerations in the control equations.

**6.1.3 Rotation-invariant, radius-dependent only**

ParentGate’s gating logic is required to be **rotation-invariant in expectation**:

* It may depend on radial shell index (k),
* but it must not single out particular angles (no privileged directions like “east is heavier than north”).

Formally:

* For any given shell (k),
  + the proportion of acts accepted vs rejected must be the same in any azimuthal direction, up to statistical fluctuations and mesh effects.
* The only allowed large-scale dependency is on **radius** (shell index), not on orientation.

This is enforced by:

* basing gate predicates on shell index, integer strictness, and local combinatorial patterns that are symmetric over rotations,
* and verifying, via audits, that there is no persistent angular bias in acceptance statistics.

By constraining ParentGate to be **radial-only and rotation-invariant**, we ensure that:

* the emergent gravitational behaviour respects the usual symmetries (e.g., spherically symmetric potentials),
* and any anisotropies must come from explicit, declared inhomogeneities in the mass/container configuration (e.g., a non-spherical mass distribution), not from hidden direction-dependent code.

**6.1.4 What ParentGate checks (at a high level)**

When the engine considers a candidate act at site (k) that involves moving some structure in +1, ParentGate examines:

* The **current shell index** (k) (or indices, if multiple centres are considered),
* The candidate’s **local pattern**:
  + how it moves mass/structure within or between shells,
  + whether it maintains or disrupts certain isotropic/structural constraints associated with those shells.

Using only integer data and booleans, ParentGate then applies rules such as:

* “In shell (k), any candidate that moves this much mass outward without corresponding inward adjustments is rejected,”
* “In deep shells (k very small), only moves that preserve a certain local isotropy pattern are allowed; all others fail,”
* “Certain excessively ‘radial-escape’ moves are disallowed once they cross the horizon shell.”

These rules are specified **once** in the manifest as simple predicates involving:

* shell index,
* local connectivity,
* counts of neighbours or transitions,
* and pre-declared structural templates.

There is no scoring; ParentGate returns either:

* **pass** → candidate remains in the survivor set,
* **fail** → candidate is discarded and never considered in later acceptance.

**6.1.5 ParentGate vs “force” in classical gravity**

In classical mechanics, we describe gravity by:

* a force field (\vec{F} = m \vec{g}),
* or equivalently, a potential (\Phi(r)),
* and then solve Newton’s or Einstein’s equations to get trajectories.

In AR/V2:

* there is no need to introduce an explicit (g(r)) or (\Phi(r)) into the control law,
* instead, the **trajectories** emerge from:
  + how ParentGate shapes the set of feasible acts at each shell,
  + combined with:
    - typed budgets and SR identity,
    - and the other structural gates.

Intuitively:

* Where classical gravity would “bend” a trajectory by a continuous force,
* ParentGate instead **denies** certain candidate outward steps asymmetrically more often than inward or tangential steps at small radii,
* resulting in an effective bending of worldlines when you look at the sequence of successful acts.

Thus, gravitational phenomena (free fall, orbital motion, deflection of light) arise as **statistics of what acts survive** the feasibility filters, not as the integrated effect of a continuous force.

**6.1.6 ParentGate as the unique site of gravity in control**

Finally, adhering to the canonical design:

* **No other component of the engine is allowed to encode gravity.**  
  This is a strict rule:
  + Θ and κ do not know about radial position except insofar as it appears as a discrete tag in the feature alphabet,
  + Structural gates cannot contain explicit “r-dependent” conditions that would duplicate gravitational behaviour,
  + The acceptance rule itself (ratio-lex + PF/Born) is blind to radius except through the residuals generated by gating.

ParentGate is therefore the **sole gravitational gate** in the control path. Its existence and form are declared in the manifest, and its behaviour is checked by dedicated audits (see Part VI and Part IX):

* Any attempt to “smuggle in” gravitational effects through other control rules would be caught as a violation of:
  + curve-ban and diagnostics-leak audits,
  + isotropy and monotonicity audits.

By constraining gravity to this one gate, we:

* keep the engine conceptually clean,
* make it possible to **prove** theorems about gravitational effects as consequences of ParentGate + budgets,
* and ensure that any “gravity-like” envelope observed in simulations can be traced back to that specific, auditable source.

**6.2 Curvature amplitude χ from UGM–Earth–Universe**

**6.2.1 Why gravity needs an amplitude**

Once we say that gravity is encoded as a feasibility gradient—via ParentGate’s radial strictness pattern—we still need to specify **how strong** that gradient is. If ParentGate rejected almost no candidates, gravitational effects would be negligible; if it rejected nearly all candidates in inner shells, everything would effectively be pinned in place.

In classical language, we would talk about a gravitational constant (G), mass (M), and perhaps a curvature scale like the Schwarzschild radius. In this framework, however, we want to avoid importing continuous field strengths directly into the control law. Instead, we introduce a single **dimensionless amplitude**:

[  
\chi  
]

which controls how steep the ParentGate strictness ladder is. All other dimensional scales are already present in the theory as part of the **hinge structure**: UGM, the Earth’s radius, and the outer container scale. χ is defined purely from these, so that gravity’s strength is not an arbitrary new parameter but a consequence of how our 0↔+1 hinge is embedded in larger contexts.

**6.2.2 Ingredients: UGM, Earth, and the outer container**

The definition of χ uses three geometric scales that the theory has already identified as structurally meaningful:

* **UGM(\_\text{phys})** (~0.1–0.12 mm):  
  The physical spatial hinge, the smallest grain at which our 0-context can treat inner structure as parts and outer structure as resolved features.
* **Earth’s radius (R\_\oplus)** (~(6.4 \times 10^6) m):  
  A characteristic scale for our +1 container:
  + the size of the world that our 0-contexts inhabit,
  + the radius around which we speak of “down” and “up,” and where we actually observe gravitational phenomena.
* **Outer shell scale (R\_{\text{obs}})** (order (10^{26}) m):  
  A characteristic radius for the **+3 cosmic shell**:
  + the scale of the observable universe or a relevant cosmological horizon,
  + which plays the role of the outermost context in which our +1/+2 structures are embedded.

With these in hand, we can form a dimensionless combination that relates:

* the depth of our local container (how “small” we are relative to the cosmic horizon),
* to the size of our world measured in units of our own spatial pixel.

**6.2.3 A natural dimensionless combination**

One natural way to combine these three scales into a dimensionless number is to take:

[  
\chi ;\sim; \frac{R\_\oplus / R\_{\text{obs}}}{\mathrm{UGM}*{\text{phys}} / R*\oplus}  
;=;  
\frac{R\_\oplus^2}{\mathrm{UGM}*{\text{phys}} , R*{\text{obs}}}.  
]

The exact numerical prefactor (whether 1, 2, (4\pi), etc.) is a matter for detailed calibration and is specified in the full gravity specification and catalog. For conceptual purposes here, what matters is:

* **The structure** of χ:
  + it is a ratio of two dimensionless quantities:
    - the fraction of the cosmic radius occupied by Earth,
    - divided by the fraction of Earth’s radius occupied by UGM.
* **The roles** of the ingredients:
  + (\mathrm{UGM}\_{\text{phys}}) injects the **spatial resolution** of our 0-context,
  + (R\_\oplus) injects the scale of our **immediate gravitational container**,
  + (R\_{\text{obs}}) injects the **outer boundary** of our environment.

χ therefore measures, in a single number, how **deeply nested** our 0↔+1 hinge is inside the cosmic hierarchy, expressed in units of our own spatial pixel.

**6.2.4 Same-frame requirement**

A crucial constraint in defining χ is the **same-frame rule**:

1. All three lengths (UGM(*\text{phys}), (R*\oplus), (R\_{\text{obs}})) must be:
   1. measured in the **same coordinate frame**,
   2. with the same unit conventions,
   3. and understood as radii in the same effective +1 environment.

No mixing is allowed between:

* comoving vs physical coordinates without careful mapping,
* or different choices of “outer radius” for different runs.

In other words:

* Before forming χ, you must commit in the manifest to a **single effective +1 frame** for Earth and its outer container.
* Once that frame is chosen:
  + UGM(*\text{phys}), (R*\oplus), and (R\_{\text{obs}}) become fixed numbers for that run,
  + and χ is computed once and held constant.

This ensures that:

* χ is a true **dimensionless constant** for the run,
* not a sliding target that can be tweaked to fit data on a case-by-case basis.

**6.2.5 What χ controls in ParentGate**

Within the ParentGate schedule, χ appears as the overall **amplitude** of the radial strictness gradient:

* Each shell k has an integer strictness (m\_k),
* The manifest defines a **family of schedules** (e.g., how (m\_k) grows as you move inward),
* χ scales or parametrizes that family.

For example (schematically):

* A baseline schedule might specify:  
  [  
  m\_k = m\_0 + \alpha\_{\mathcal{P}} , \chi , f(k),  
  ]  
  where:
  + (m\_0) is a base strictness at large radii,
  + (\alpha\_{\mathcal{P}}) is a **dimensionless pattern-family constant** (catalog-locked, not fit per run),
  + (f(k)) encodes the shape of the radial profile (e.g., (f(k) \sim 1/r\_k) in discrete form).

In that example:

* If χ = 0:
  + there is no additional gravitational strictness beyond the base m₀,
  + worldlines behave as if there were no gravity (flat SR case).
* If χ is small but nonzero:
  + there is a mild inward-increasing probability of rejecting outward-steep acts near the centre,
  + producing subtle gravitational redshift, deflection, and time-delay effects.
* If χ is larger:
  + the gradient steepens,
  + and strong-field phenomena (near-horizon behaviour) can appear.

Thus:

* χ is the **single knob** that determines the overall strength of gravitational feasibility gradients for a given hinge and schedule family.
* Its value is wholly determined by the **geometric relationship** between UGM, Earth’s size, and the outer cosmic container; it is not an independent empirical parameter.

**6.2.6 χ as the hinge’s gravitational fingerprint**

From the perspective of the full theory:

* The triple ((\mathrm{UGM}*{\text{phys}}, R*\oplus, R\_{\text{obs}})) is already needed to describe:
  + the spatial resolution of our 0-context (UGM),
  + the size of our immediate environment (+1),
  + and the scale of the outer shell (+3).
* χ is then the natural way to summarize, in a single number, how “tightly nested” our 0-context is within its galactic and cosmic containers.

This gives gravity a **geometric–relational origin**:

* Its strength is not just a mysterious constant; it is a measure of:
  + the **ratio** between:
    - how many UGM-scale steps span the Earth,
    - and how many Earth radii fit into the cosmic horizon.

In that sense:

χ is the **gravitational fingerprint of our hinge**. It tells you how much the present-act engine must bias feasibility inwards, in order for acts at the 0↔+1 scale to be consistent with the way our container (+1) sits inside +2 and +3.

Later, when we examine weak-field envelopes and T-series results, χ will appear repeatedly as the quantity that scales:

* redshift per radial decade,
* delay per log impact parameter,
* deflection per unit mass/container,

all without ever being introduced as a separate “force strength” in the control law.

**6.3 Weak field envelopes**

**6.3.1 What “weak field” means here**

In this framework, a **weak gravitational field** is a regime where ParentGate’s influence is **small enough** that:

* the underlying SR structure (typed budgets, light-cones, invariant (c)) is still clearly visible,
* ParentGate changes the statistics of feasible acts only **slightly** compared to the gravity-OFF case,
* and we can treat gravitational effects as **small corrections** to an otherwise “flat” feasibility pattern.

Formally, this means:

* Strictness levels (m\_k) are nonzero and inward-monotone, but not so large that inner shells are nearly frozen,
* For each shell, the fraction of candidates rejected by ParentGate is modest,
* The other gates (Θ, κ, structural) and the SR budget identity still dominate the gross behaviour of worldlines.

In this weak-field window, it makes sense to talk about **envelopes**:

* smooth curves that summarize how:
  + redshift,
  + time delay,
  + deflection,
  + and horizon-like behaviour
* depend on radius r or impact parameter b,
* even though the engine itself only ever makes discrete, boolean decisions per act.

These envelopes are **diagnostic summaries** of patterns seen in simulations, not control-side laws.

**6.3.2 Redshift envelopes**

To diagnose **gravitational redshift**, we compare clocks (or clock-like processes) at different radii in the same container.

Set-up:

1. Place identical 0-context clocks at two radii (r\_1) and (r\_2) (e.g., deeper and higher in a gravitational field),
2. Let them run for many acts under the same manifest, with ParentGate **ON**,
3. For each clock, measure:
   * how many inner ticks (\Delta \tau) accumulate per outer-time increment (\Delta t).

Because ParentGate is stricter in inner shells:

* Candidates that would advance outer relations “too easily” at small r are more likely to be rejected,
* This subtly changes how acts allocate (\Delta \tau) and (\Delta t) deeper in the container compared to farther out.

Diagnostics:

* We can define an effective frequency or tick rate (f(r)) at each radius,
* And then compute a **redshift factor** between shells:  
  [  
  1 + z(r\_1, r\_2) = \frac{f(r\_1)}{f(r\_2)}.  
  ]
* In the weak-field window, this factor typically follows an approximate envelope:  
  [  
  1 + z(r\_1, r\_2) \approx 1 + \alpha\_{\mathcal{P}} , \chi , \Phi(r\_1, r\_2),  
  ]  
  where:
  + (\alpha\_{\mathcal{P}}) is the pattern-family constant for the schedule,
  + (\chi) is the curvature amplitude,
  + (\Phi) is a simple radius-dependent function (e.g., proportional to (1/r) differences or a potential-like term).

Key point:

* This envelope is **fitted in diagnostics** from counts and budgets,
* It is never used by control; the engine only knows about ParentGate’s pass/fail rules.

**6.3.3 Shapiro-like delay envelopes**

For **time delay**, we consider “light-like” or high-speed signals travelling near the centre of a mass-like container.

Set-up:

* Run two simulations (or two conditions in one run):
  + **Gravity OFF** (ParentGate disabled),
  + **Gravity ON** (ParentGate enabled with a given schedule and χ).
* For a given path between points A and B in +1, and for a range of **impact parameters** (b) (how close the path passes to the centre), measure:
  + travel time (t\_{\text{OFF}}(b)) with ParentGate OFF,
  + travel time (t\_{\text{ON}}(b)) with ParentGate ON.

Define the **extra delay**:

[  
\Delta t(b) = t\_{\text{ON}}(b) - t\_{\text{OFF}}(b).  
]

In the weak-field regime:

* Paths that graze closer to the centre (smaller (b)) experience more frequent rejections of “straight-line” candidates and more detours in the discrete path structure,
* This results in longer average travel times.

Diagnostics:

* Plot (\Delta t(b)) versus (b) on appropriate axes,
* In many cases, we find a log-type behaviour over a certain range:  
  [  
  \Delta t(b) \approx \alpha\_{\mathcal{P}} , \chi , R\_\oplus , \log!\left(\frac{L}{b}\right),  
  ]  
  where:
  + (R\_\oplus) is the container radius (e.g., Earth or galaxy),
  + (L) is a reference length scale,
  + and the coefficients are determined by the schedule family and χ.

This mirrors the classical **Shapiro delay** formula in GR, but in AR/V2 it is purely:

* the empirical envelope of:
  + how many more acts it takes, on average, for near-centre paths to survive ParentGate compared to gravity-OFF runs.

**6.3.4 Deflection and lensing envelopes**

To probe **deflection and lensing**, we simulate rays (or ray-like worldlines) passing near a centre and measure how much their paths bend compared to gravity-OFF baselines.

Set-up:

* Emit many high-speed or effectively lightlike paths from a distant source plane,
* Let them pass near the mass centre with varying impact parameters (b),
* Observe where they arrive on a distant screen plane.

With ParentGate OFF:

* Paths follow approximately straight lines in +1 coordinates (modulo mesh effects),
* The distribution on the screen is concentrated around the straight-line expectation.

With ParentGate ON:

* Paths that pass closer to the centre experience:
  + more rejections of purely straight outward moves,
  + more acceptance of slight inward or tangential detours,
* The cumulative effect is a **deflection** of the trajectory away from the “naively straight” direction.

Diagnostics:

1. For each impact parameter (b), compute a mean deflection angle (\theta(b)) from the screen distribution,
2. In weak fields, we typically find:  
   [  
   \theta(b) \approx \frac{\alpha\_{\mathcal{P}} , \chi , R\_\oplus}{b},  
   ]  
   over a range of b where:
   * ParentGate is non-negligible but not so strong as to produce multiple images or near-horizon behaviour.

Again:

* This 1/b envelope is **fitted from counts**; it is not imposed on the engine.
* It can then be compared with astrophysical lensing profiles in T-series analyses (T3/T3 B).

**6.3.5 Horizon-related behaviour in the “edge” of the weak regime**

In stronger fields, but still within a regime where SR-like structure is visible, we may approach an effective **horizon**, defined operationally as:

* a radius (r\_h) within the container such that:
  + no outward worldline from inside (r < r\_h) can reach (r > r\_h) without being rejected by ParentGate.

In the vicinity of this horizon:

* redshift factors grow large,
* delays and deflections deviate from simple linear/log envelopes,
* and the discrete availability of outward acts collapses to nearly zero at and inside (r\_h).

In the **weak-field portion** just outside the horizon:

* the same envelope forms (for redshift, delay, deflection) still give useful approximations,
* but diagnostics will show:
  + growing residuals between fitted envelopes and actual counts as one approaches (r\_h),
  + signalling the transition to a qualitatively different, strong-field regime.

The key idea is:

* Even horizon-like behaviour is read off from **feasibility patterns** (reachability, redshift, deflection),
* and in the weak to moderate regime, those patterns admit simple envelope descriptions similar to GR,
* but they remain purely **diagnostic summaries** of ParentGate’s influence on the act structure.

**6.3.6 Envelopes as diagnostic summaries, not control laws**

Throughout:

* The engine’s control path uses only:
  + ParentGate’s boolean pass/fail decisions,
  + gate ladders,
  + typed budgets,
  + and the ratio-lex + PF/Born acceptance rule.
* It never explicitly computes:
  + redshift functions,
  + deflection angles,
  + Shapiro delays,
  + or horizon radii.

These quantities appear only in **diagnostics**, where we:

* aggregate large numbers of acts and worldlines,
* fit simple functional forms to the observed statistics,
* and compare them with empirical data.

This separation is crucial:

* It keeps the engine clean: gravity is fully encoded via ParentGate + χ + budgets,
* It allows us to interpret familiar GR-like formulas (redshift, deflection ∝ 1/b, delay ∝ log) as **emergent envelopes** of discrete feasibility geometry,
* And it ensures that any matching to observational data is a matter of **diagnostic fit**, not a matter of “baking GR into” the control rules.

In summary, **weak field envelopes** are:

* the smooth curves we infer from how the present-act engine behaves under a given ParentGate schedule and χ,
* and they provide the bridge between:
  + the discrete, relational description of AR/V2,
  + and the continuous, approximate descriptions we use in standard gravitational physics.

**6.4 Connection to +2/+3 and T3 B**

**6.4.1 Placement of gravity in the context ladder**

Gravity, in this framework, is not confined to the immediate 0↔+1 hinge. Its large-scale structure is controlled by the **outer context bands**:

* **+2** – galactic disk band (kpc scales),
* **+3** – cosmic shell/horizon band (tens–hundreds of Mpc to Gpc).

From our 0↔+1 hinge:

* +2 (e.g., the Milky Way) is the **container** for Earth and its environment,
* +3 is the **outer shell** that encloses our galaxy and local group.

ParentGate schedules are therefore:

* defined not only with respect to local Earth-scale shells, but also with respect to:
  + the **galactic container** (+2),
  + and the **cosmic shell** (+3),
* and χ encodes how deeply our 0↔+1 hinge sits inside these outer contexts.

This makes gravity inherently a **multi-level context phenomenon**:

* near-Earth behaviour (e.g., local free fall),
* galaxy-scale behaviour (rotation curves, RAR),
* and cosmological behaviour (lensing, redshift),

are all expressions of how ParentGate organizes feasibility in +1 under the influence of +2 and +3.

**6.4.2 +2 and +3 as disk and shell containers**

Static evidence (from 3.2) shows:

* **+2 (galactic disk)**:
  + GM pivots in the ~0.3–4 kpc band,
  + fractal dimensions D ≈ 2 in many HI/HII distributions,
  + indicating a **thin, sheet/disk-like container** for planetary systems and local environments.
* **+3 (cosmic shell/horizon)**:
  + GM pivots at very large scales (tens–hundreds of Mpc up to Gpc),
  + D ≈ 2 for structures interpreted as large-scale walls/shells,
  + consistent with a **shell-like outer boundary** for the observable universe.

In AR/V2:

* +2 and +3 are not just scales; they are **context roles**:
  + +2: the “galactic CS” containing many +1 environments,
  + +3: the “cosmic CS” containing many +2 containers.
* ParentGate schedules at these levels:
  + adjust strictness as a function of radius in ways that reflect:
    - how deeply a given region is nested within galactic and cosmic containers,
    - and how χ, derived from UGM–Earth–Universe, modulates feasibility gradients across those bands.

This connects the **global shape** of space (disk + shell) directly to how gravity is implemented as feasibility geometry.

**6.4.3 T3: lensing amplitudes and size dependence**

The **T3** analysis looks at galaxy–galaxy lensing and asks:

* How does the **lensing plateau amplitude** (A\_\theta) depend on galaxy **size** (R\_G) and mass (M\_\star)?

Empirically:

* In mid and high stellar-mass bins:
  + larger (R\_G) at fixed (M\_\star) tend to show **higher** plateau amplitudes,
  + contrary to simple GR+DM expectations where spreading mass out at fixed mass typically reduces deflection.
* In the low-mass bin:
  + this effect is absent or much weaker.

From the AR/V2 viewpoint:

* This pattern hints that:
  + once galaxies cross certain size thresholds (in +2 band),
  + they begin to “feel” an additional feasibility gradient tied to their position in +2/+3,
  + while smaller systems remain dominated by local, baseline feasibility geometry with little extra container-level contribution.

T3, by itself, reveals a **size-dependent gravitational effect** that is not easily explained by naive GR+DM, but is suggestive of **container activation** at the galactic context level.

**6.4.4 T3 B: Milky Way–anchored activation at the +2↔+3 seam**

T3 B makes this suggestion precise by introducing an explicit **Milky Way–anchored activation test**:

* It defines a **dimensionless size** (x) for each lens galaxy in terms of:
  + its physical size (R\_G),
  + and a Milky Way reference scale (R\_{\text{MW}}) that may depend on mass (e.g., via a scaling relation).
* For each lens stack (mass bin, size bin), it computes an **activation proxy**:
  + e.g., the **fraction of lenses** with (x \ge 1),
  + or similar measures of how many systems are at or above a MW-like scale.

Then, within each mass bin, T3 B compares two models for (A\_\theta):

* **Size-only model**:  
  [  
  A\_\theta = a + b , R\_{G,\text{mid}}  
  ]
* **Size+activation model**:  
  [  
  A\_\theta = a + b , R\_{G,\text{mid}} + d , \text{ActivationProxy}  
  ]

Using AIC/ΔAIC (or similar) for model comparison:

* In datasets like DR5:
  + the size+activation model is strongly preferred (large positive ΔAIC),
  + the best-fit MW reference scale (R\_{\text{MW}}) falls in a **few-kpc band** (e.g., 4–7 kpc),
  + which aligns with the +2 CL galactic disk scale for the Milky Way.
* KiDS and other datasets:
  + may be coverage-limited, but do not contradict this pattern:
    - low-mass bins still show weak/no size effect,
    - mid/high bins admit compatibility with an activation term around a MW-like scale.

Interpretation in AR/V2:

* +2↔+3 seam:
  + is exactly where the theory predicts **container activation**: a change in feasibility geometry tied to a MW-scale container within the cosmic shell.
* T3 B’s results:
  + show that **including MW-scale activation** improves the explanation of lensing amplitudes,
  + and localizes the activation scale to the expected +2 band.

Thus, T3 B provides **direct empirical support** for the idea that:

+2/+3 containers (like the Milky Way inside a cosmic shell) are genuinely shaping feasibility geometry, and that a MW-scale activation term is needed to explain observed lensing data in a way consistent with the AR/V2 feasibility framework.

**6.4.5 How this anchors the feasibility geometry picture**

The connection to +2/+3 and T3 B is crucial for making the gravitational feasibility story concrete:

* It shows that the **same structural elements**:
  + context ladder (−2…+3),
  + hinge triple (UGM–Earth–Universe),
  + χ amplitude,
  + ParentGate schedule families,
* are not just capable of explaining local gravity (e.g., near-Earth free fall) or isolated toy models, but also:
  + galaxy-scale rotation curves (T1),
  + the RAR slope (T2),
  + and the **size- and container-dependent** lensing amplitudes in real surveys (T3/T3 B).

When we say “gravity is feasibility geometry,” we therefore mean:

* at local scales:
  + ParentGate + budgets produce stable free-fall, redshift, delay, and deflection envelopes,
* at galactic/cosmic scales:
  + +2/+3 containers, with χ determined by UGM–Earth–Universe, generate activation patterns that match observed phenomena like MW-scale lensing enhancements.

T3 B, in particular, is part of the **core “on record” bundle**:

* It documents that a MW-anchored, +2↔+3 seam activation:
  + is not an ad hoc idea, but is **empirically favoured** by the data when compared with size-only models,
  + and it does so in exactly the size band the theory earmarks for a galactic container.

This is one of the strongest pieces of evidence that:

* gravity can be understood as a **present-act feasibility gradient** shaped by the context ladder,
* rather than as a fundamental interaction mediated by a separate continuum field in control.

**Part VII – Quantum and Matter from Context Relations**

**7.1 −2 seam & quantum behaviour**

**7.1.1 The −2 seam as a real contextual boundary**

In the context ladder, the **−2 level** is not just “small stuff.” It is a specific **inner seam** where, from the vantage of +1, our usual way of representing structure starts to thin out. This seam is:

* **Scale-defined**:  
  Empirically concentrated in the **1–200 nm** band:
  + DNA geometry (diameter, base-pair spacing),
  + chromatin nano-domains,
  + membrane rafts and nano-clusters,
  + nanoporous materials, soot aggregates, and diffusion-limited clusters.
* **Fractally characterized**:  
  Fractal windows in this band show:
  + well-defined geometric-mean (GM) pivots,
  + multiple D(L) plateaus and breaks inside the 10–200 nm range,
  + with DNA↔cell/nucleus geometric means repeatedly landing in ~60–140 nm.

From the AR/V2 point of view:

* −2 is where **inner structure is rich**, but
* +1’s representation of that structure is **no longer able to uniquely pin down all micro-configurations**.

This makes −2 the natural **quantum seam**:

* it is where many micro-histories can be simultaneously compatible with the same +1 picture,
* and where the engine’s selection (L3 role) must pick one realized outcome from many co-eligible alternatives.

**7.1.2 Co-eligibility as “superposition”**

At −2, V2 gates often leave multiple micro-candidates **co-eligible**:

* **Selectors $U$ and $\Psi$ enumerate** several possible micro-configurations for the next act,
* **Hinge equality** finds more than one pair ($(w,q)$) that match in the finite feature alphabet,
* **Gates ($\Theta$, $\kappa$, structural, ParentGate, and CRA):**
  + may remove some candidates as infeasible,
  + but frequently **do not eliminate all but one** at the −2 scale.

The result is a **tie family** of micro-histories that are:

* **distinct** at −2,
* but **indistinguishable** at +1 given the current resolution and context.

From our vantage, this is what we call a **superposition**:

* It is not a mysterious wave spread over space,
* it is a **set of co-eligible micro-histories** that share the same +1-facing features,
* and thus **cannot yet be differentiated** by the engine at the current hinge resolution.

In other words:

Superposition = “the engine has multiple −2 candidates that all look like the same world at +1, and all survived feasibility up to this point.”

**7.1.3 Collapse as L3 selection via PF/Born ties-only**

Eventually, the engine must choose a **single** micro-history to continue the actual 0-context’s timeline. This is the L3 role: **unification**. In V2, this happens exactly when:

* we have a tie set (\mathcal{T} = {c\_1,\dots,c\_N}) of survivors that:
  + have identical residual triples (out/in/cross),
  + cannot be distinguished by fewest-acts tiebreak,
  + and thus are truly equal from the engine’s discrete standpoint.

At that point, the PF/Born mechanism applies:

* **Construct tie adjacency** over (\mathcal{T}):
  + build a small adjacency matrix representing which candidates are “neighbours” in structure or context,
  + using only discrete, manifest-declared rules.
* **Form a primitive column-stochastic kernel** (M) on (\mathcal{T}):
  + each column sums to 1,
  + a tiny (\eta) may be added to ensure primitivity (every candidate eventually reachable),
  + kernel entries are fully determined by the adjacency, not by data fits.
* **Compute the Perron–Frobenius eigenvector** (v) of (M):
  + the unique (up to scaling) eigenvector with strictly positive components.
* **Define Born-style weights**:  
  [  
  w\_j \propto v\_j^2,  
  ]  
  normalized so (\sum\_j w\_j = 1).
* **Randomly select exactly one candidate** from (\mathcal{T}) using (w\_j) and the configured RNG.

The chosen candidate becomes:

* the **actual micro-history continuation** at −2 for the act,
* whose effects propagate into −1, 0, and +1.

From the outside, this appears as **collapse** of a superposition to one outcome. In AR/V2 terms, it is simply:

L3 doing its job: selecting one continuation in cases where the engine’s discrete rules cannot distinguish candidates and must defer to a neutral, symmetric random choice.

**7.1.4 Entanglement as correlated tie structure**

Quantum **entanglement** arises naturally once we recognize that:

* tie sets (\mathcal{T}) often involve **joint configurations** of multiple −2 subsystems.

Consider two −2 subsystems A and B (e.g., two photons, two spins, two molecular sites):

* Their joint candidate space may include many pairs ((a\_i, b\_j)),
* Feasibility and CRA-like gates will often restrict these pairs:
  + some combinations are forbidden by local structure,
  + others survive as **co-eligible joint alternatives**.

The resulting tie set (\mathcal{T}) is then:

* not a simple product of independent tie sets for A and B,
* but a **correlated subset** that encodes which joint micro-histories are admissible.

When PF/Born is applied:

* it picks one joint outcome ((a\_i, b\_j)) from the correlated tie set,
* preserving whatever constraints the correlation structure imposes.

From a higher-level viewpoint:

* these correlations manifest as **non-factorizable joint probabilities**:
  + exactly what we see in Bell-type experiments,
  + where measurement outcomes on A and B are correlated beyond simple product distributions.

Crucially:

* the engine still respects **no-signalling**:
  + local marginals for A (alone) and B (alone) remain independent of remote choices,
  + enforced by CRA gates and audits on the PF/Born implementation.

So entanglement is:

the behaviour of **correlated tie sets** under PF/Born ties-only selection: multiple −2 subsystems share a tie structure, so when one outcome is chosen, correlated outcomes appear elsewhere, without any superluminal influence in the engine.

**7.1.5 No primitive wavefunction: amplitudes as effective summaries**

In standard quantum mechanics, we postulate:

* a wavefunction (\psi),
* a Hilbert space,
* and a Born rule (P = |\psi|^2).

In AR/V2, we invert the logic:

* We do **not** start with a wavefunction as a primitive object.
* Instead, we start with:
  + discrete candidate sets,
  + feasibility gates,
  + tie adjacency,
  + and a PF/Born rule on ties only.

From there:

* If one wanted to build an **effective Hilbert-space description**, one could:
  + take the tie sets and their adjacency,
  + define amplitude-like objects from the PF eigenvector components (v\_j),
  + and show that, in appropriate limits, their squared magnitudes correspond to observed frequencies.

But at the engine level:

* the fundamental objects are **qualitative candidates and their discrete relations**, not wavefunctions.
* “Amplitude” is a convenient way of summarizing:
  + the structure of the adjacency matrix,
  + and the stationary distribution of a neutral stochastic process,
  + which the engine uses only in the **rare case of exact ties**.

This shift has two key conceptual payoffs:

* **Unification**  
  Quantum probabilities and classical probabilities both arise from the **same PF/Born mechanism**, applied at different scales and with different tie structures.
* **Clarity about where “quantumness” lives**  
  Quantum behaviour is localized to:
  + the **−2 seam** (and sometimes at −1/0 when micro-coherence survives),
  + where many micro candidates are genuinely co-eligible,
  + and the PF/Born rule must be invoked.

Above those levels, once ties are rare and many acts have unique winners, behaviour becomes effectively classical.

In this way, the −2 seam is not just a small-scale band in metres; it is:

* the **inner context level** where co-eligibility is common,
* where L1/L3 roles play out as “superposition and collapse,”
* and where “quantum behaviour” is nothing but the name we give to how the present-act engine behaves when it cannot distinguish micro-histories at +1 resolution.

**7.2 EM and charge as inclusion patterns**

**7.2.1 Charge as relational inclusion bias**

In this framework, **charge is not a primitive substance** carried by particles and inserted into field equations. Instead, it is a **diagnostic label** for a persistent bias in how inclusion relations between 0 and +1 are organized around a centre.

Consider a candidate centre (an atomic nucleus, an effective charge centre in a material, or some localized structure). Around that centre:

* The engine builds outward configurations in +1 by stitching together acts that:
  + may or may not rely on **routes that pass through the centre’s inner structure** (0-anchored inclusion),
  + or may bypass it, involving more distributed “background” structure ( +1-dominant inclusion).

We define, in diagnostics:

* A **0-anchored inclusion event** when feasibility for an act in some annulus:
  + explicitly requires inclusion of the centre’s structure (e.g., its −1/−2 degrees of freedom) to pass gates,
  + rather than being feasible purely as a +1-level pattern.
* A **+1-dominant inclusion event** when feasibility:
  + can be achieved without such dependence on the centre,
  + or is dominated by other large-scale features of +1.

If, over many acts and many configurations, we count:

* (N\_+) = number of 0-anchored inclusion events,
* (N\_-) = number of +1-dominant inclusion events,

we can define a **signed inclusion count**:

[  
Q\_A = N\_+ - N\_-  
]

in a chosen region (A) around the centre, and a normalized quantity (q\_A = Q\_A / |W\_t|) (or similar). We then interpret:

* positive (Q\_A) (more 0-anchored events) as one **polarity** (say, “positive charge”),
* negative (Q\_A) (more +1-dominant events) as the opposite polarity (“negative charge”).

Thus, **charge** is:

A measure of how strongly the environment’s feasibility depends on routes that go through a given centre’s inner structure, as opposed to routes that bypass it.

**7.2.2 E-like patterns: 0-anchored inclusion over shells**

Once we have a signed inclusion measure around a centre, we can look at how it depends on radius. We consider a set of **concentric annuli or shells** ((A\_m)) around the centre in +1 and compute:

* (Q\_{A\_m}) = signed inclusion in each shell.

We then examine:

* the **cumulative inclusion** up to radius (r\_m),
* and check for patterns such as:
  + a plateau in total (Q(r)) at large radii (analogous to flux conservation),
  + or a simple radial dependence of inclusion density.

An **E-like diagnostic** can be defined by:

* taking finite differences or normalized versions of (Q\_{A\_m}):
  + e.g., (E(m) \sim Q\_{A\_{m+1}} - Q\_{A\_m}),
  + or via differences in acts-inflation (D(r)) near the centre vs far away.

In suitable bands (especially β₋₁ and β₀, where atomic and molecular structure is relevant):

* we often find that, within a mesh-validated window,
  + the E-like diagnostic behaves like an inverse-distance law (1/r) or inverse-square law (1/r²), depending on effective geometry,
  + and that there is a stable notion of “field strength” in that window.

Importantly:

* These E-like patterns are **not stored or used in control**,
* They are derived purely from **counts of how inclusion biases vary with radius** around the centre in diagnostics.

**7.2.3 B-like patterns: circulation and re-expression**

Where E-like patterns capture radial inclusion bias, **B-like patterns** capture **circulation** and **dynamical re-expression** of inclusion around a centre.

Diagnostics for B-like behaviour involve:

* Choosing closed loops (or loop families) around the centre,
* Counting **oriented crossing events**:
  + how often inclusion patterns “circulate” around the centre in a preferred sense,
  + measuring something like discrete circulation or curl.

At the same time, we track:

* **Re-expression events**:
  + times when the internal configuration of the centre or its immediate surroundings undergoes a structural change (e.g., changes in −1/−2 pattern labels, band transitions, or context tags),
  + acting as a proxy for “current” or “motion” of charge-like patterns.

A simple B-like diagnostic might be:

[  
B \propto \text{circulation rate} \times \text{re-expression rate},  
]

where both factors are computed from counts of discrete events in logs.

In bands where EM behaviour is meaningful:

* β₋₂ / β₋₁ / β₀:
  + we expect to see:
    - non-zero B-like signals when inclusion is not static but twisting around the centre,
    - correlations between E-like patterns and B-like circulation (e.g., when charges move, B increases),
    - consistent phase relationships between oscillatory E and B signals (e.g., in EM-wave diagnostics).

Again:

* These B-like patterns are purely **diagnostic**:
  + used to infer EM-like behaviour from present-act structure,
  + not used by the engine to steer feasibility or acceptance.

**7.2.4 Light as oscillatory inclusion between 0 and +1**

In this framework, **light and EM radiation** are interpreted as **oscillatory patterns of inclusion** between 0 and +1:

* E-like patterns:
  + represent how strongly +1 feasibility depends on 0-anchored inclusions in a region,
* B-like patterns:
  + represent how these inclusion patterns circulate and are dynamically re-expressed over time.

An EM wave, in this view, is:

A travelling pattern in which E-like and B-like inclusion diagnostics oscillate in phase-locked fashion, propagating through the +1 environment at speed (c).

Simulation diagnostics show:

* E(t, r, direction) and B(t, r, direction) signals with:
  + a stable phase relationship (e.g., one leading the other by a fixed amount),
  + consistent polarization properties (orientation of oscillations),
  + top-of-front propagation at effective speed (\hat{c} \approx c) (from budgets).

These emergent behaviours:

* arise purely from:
  + the interplay between:
    - local present-acts,
    - feature maps and gates,
    - and ParentGate/schedule where gravity is included,
* and are captured by counting discrete events (inclusion, circulation, re-expression) across space and time.

The engine does not need to contain explicit Maxwell equations; those can be recovered as **effective envelope descriptions** of:

* how inclusion patterns propagate,
* in contexts where:
  + the lattice is fine enough,
  + and the band (β₋₂/β₋₁/β₀) is such that continuous approximations make sense.

**7.2.5 EM as band-specific relational geometry**

Finally, it is important to emphasize that EM behaviour is **band-specific**:

* **β₋₂ (subatomic)**:
  + EM-like behaviour appears in quantum regimes:
    - near-field interactions,
    - tunnelling, discrete transitions,
    - strong coupling to quantum co-eligibility and PF/Born selection.
* **β₋₁ (atomic)**:
  + EM governs:
    - binding of electrons to nuclei,
    - discrete energy levels,
    - atomic-scale field patterns.
* **β₀ (molecular)**:
  + EM governs:
    - bond formation/breaking,
    - molecular spectra,
    - charge distributions and dipole moments,
    - fields in crystals and condensed phases.
* **β₊₁ (macro)**:
  + EM appears as:
    - classical fields,
    - macroscopic circuits,
    - antennas, waves, radiation, etc.

Across all these bands, the unifying idea is:

EM is the **relational geometry of inclusion** between 0 and +1 (and their inner structures) — how often and in what patterns the environment needs to route feasibility through specific centres and how those patterns are re-expressed in time.

Charge, E, B, and light are therefore not **extra substances** in the theory. They are:

* ways of describing recurring present-act patterns,
* read off from counts and structure of inclusion events across shells, loops, and time,
* constrained by the same engine rules and context ladder that govern SR, gravity, and quantum behaviour.

**7.3 Atoms, molecules, classical limit**

**7.3.1 Atoms as long-lived single-center coherence (β₋₂/β₋₁)**

In the AR/V2 framework, an **atom** is not a tiny billiard ball or a point with intrinsic fields. It is a **pattern of long-lived coherence** centered on a specific locus in the −2/−1 bands, as seen from our 0↔+1 hinge.

From the engine’s perspective:

* At −2 and −1 (nanometre and micron bands):
  + there are many candidate micro-configurations involving:
    - a central nucleus-like structure,
    - surrounding electronic and molecular degrees of freedom.
* Gates (Θ, κ, structural, ParentGate, CRA) and hinge equality:
  + filter micro candidates,
  + favour those that are:
    - temporally stable over Θ windows,
    - spatially coherent over κ granularities,
    - structurally contiguous and isotropic in appropriate ways.

A **single-center L2 coherence** pattern is one where:

* For many consecutive acts:
  + the centre’s key features (band, charge-like tags, structural labels) remain within a small finite set of states,
  + even though −2-level details may fluctuate underneath.
* From +1’s perspective:
  + the centre appears as **the same entity** across many acts:
    - same “place” (within UGM resolution),
    - same effective properties (e.g., charge tag, spin-like labels, etc.).

In this sense:

An atom is a centre in β₋₂/β₋₁ whose −2 and −1 micro-configurations repeatedly pass the gates in such a way that, over many acts, the present-act engine treats it as one persistent single-center coherence pattern.

When the engine encounters certain changes in this pattern (e.g., transitions between metastable coherence configurations), we see them as:

* **Discrete energy-level transitions**,
* **Emission or absorption of light** (EM re-expression events),
* **Quantum jumps** in traditional language.

All of these are expressions of:

* how long-lived single-center coherence at −2/−1 behaves under:
  + PF/Born selection at ties,
  + and the relational inclusion geometry that defines EM-like behaviour.

**7.3.2 Molecules as multi-center coherence (β₀)**

At the β₀ band (roughly the molecular scale), coherence extends beyond individual centres to **multi-center patterns**. A **molecule** is then:

A pattern of L2 coherence involving multiple atomic centres that the engine treats as a single unit at β₀, across many acts.

From the engine’s perspective:

* Many candidate micro-configurations exist for:
  + how two or more atomic centres can share inclusion patterns (E-like/B-like), bond-angles, and local environment.
* Gates and hinge equality favour multi-centre patterns that:
  + are temporally stable (Θ),
  + persist at certain granularity (κ),
  + maintain structural integrity (contiguity, degree constraints, orientation uniqueness),
  + respect EM-like inclusion constraints (charge and inclusion balancing around and between centres).

A **bond** in this language is:

* a region of **enhanced co-eligibility** and coherence between centres:
  + where candidate micro configurations that keep the centres in a specific spatial and relational arrangement:
    - are consistently favoured by gates,
    - have lower residuals,
    - and thus recur over many acts.

Different bond types correspond to different multi-centre coherence motifs:

* **Directional / localized bonds**:
  + coherence tightly constrained along specific directions between centres,
  + analogues of σ-bonds, localized covalent bonds.
* **Delocalized / ring-like bonds**:
  + coherence distributed over multiple centres in loops or extended structures,
  + analogues of π-bonds, aromatic systems, conduction bands.
* **Weak/cohesive bonds**:
  + coherence patterns that exist but fail easily under small perturbations,
  + analogues of van der Waals or hydrogen bonds.

When these multi-centre coherence patterns are:

* sufficiently persistent in time,
* robust under typical fluctuations in the environment,

the engine treats the entire configuration as **one part** at β₀:

1. a single “molecule” that can be:
   * moved,
   * rotated,
   * or excited as a unit in many present-acts.

**7.3.3 Classical limit: β₊₁ band and rare ties**

At the β₊₁ band (macro scale), we approach what we normally call the **classical limit**:

* Single-center and multi-center coherence patterns (atoms, molecules) are aggregated into:
  + larger assemblies: solids, fluids, macroscopic objects.
* From the engine’s perspective:
  + at this scale, the number of micro-acts and micro-candidates per macro-step is huge,
  + but the probability that **distinct macro-candidates** are:
    - exactly tied in residuals,
    - and equally minimal in fewest-acts,  
      becomes extremely small.

That is:

* At β₊₁,
  + most candidate macro-level transitions have a **unique discrete winner** after gates and ratio-lex,
  + PF/Born ties-only rarely, if ever, triggers at that scale.

Consequences:

* **Micro-level co-eligibility** at −2 (quantum seam) still exists,
  + but by the time we aggregate decisions to the β₊₁ band, most micro randomness has:
    - been averaged out,
    - or led to macroscopically indistinguishable variations.
* The macro worldlines at β₊₁:
  + appear **effectively deterministic**,
  + follow trajectories that obey SR budgets and gravitational feasibility on average,
  + and can be described by classical equations of motion to good approximation.

From this standpoint:

The classical limit is the regime where PF/Born random selection still happens at −2, but the density of macro-scale ties is so low that β₊₁ behaviour is effectively deterministic, with quantum fluctuations showing up only as small perturbations or noise.

**7.3.4 Role of environment and decoherence in AR/V2 terms**

What is called **decoherence** in standard quantum mechanics appears here as:

* the **loss of observable co-eligibility** at higher context bands (−1, 0, +1),
* due to extensive coupling of −2 micro-systems to:
  + other −2 systems,
  + larger −1/0 structures (e.g., molecules, objects),
  + and the +1 environment.

Mechanistically:

* As a −2 micro pattern becomes more entangled with many degrees of freedom:
  + tie sets involving it become extremely large and complex,
  + gates at higher bands (e.g., κ, structural) and coarse-graining at β₀/β₊₁ compress:
    - many micro alternatives into effectively indistinguishable macro states.
* PF/Born at −2:
  + continues to select one outcome from each tie set,
  + but the **macro aggregation** of those selections:
    - seldom yields different outcomes in coarse-grained diagnostics,
    - so we say that “coherence has been lost” at the observable scale.

From AR/V2’s perspective:

* There is no separate “collapse vs unitary evolution” dichotomy,
* There is only:
  + unitary-like branching at the level of co-eligible candidates (L1),
  + and discrete L3 selection via PF/Born ties-only,
  + happening at all levels but only *visible* as quantum phenomena in contexts where:
    - tie sets are small enough and structured enough,
    - and gates do not wash out their consequences.

“Decoherence” is thus:

The regime where present-acts on many degrees of freedom and multiple bands conspire to make PF/Born’s micro-level selections irrelevant to coarse-grained, β₊₁ descriptions—producing the appearance of classical behaviour.

**7.3.5 Summary: layered coherence from quantum to classical**

Putting it all together:

* **Atoms**:
  + long-lived single-center coherence patterns at β₋₂/β₋₁,
  + maintained by:
    - repeated gate passes,
    - stable tie structures,
    - and EM-like inclusion patterns.
* **Molecules**:
  + multi-center L2 coherence patterns at β₀,
  + where atomic centres are bound into persistent networks of inclusion and structure,
  + forming functional units in the world.
* **Macroscopic objects (classical world)**:
  + large aggregates at β₊₁,
  + where PF/Born ties-only rarely appears at the macro candidate level,
  + and the behaviour of objects is dominated by:
    - SR budgets,
    - gravity as feasibility geometry,
    - and aggregated matter/EM relations.

Quantum and classical are thus not two fundamentally different regimes, but two **band-specific views** of the same present-act engine:

* At −2, co-eligibility and PF/Born selection dominate:
  + we see quantum interference, entanglement, and discrete spectra.
* At β₊₁, unique winners and coarse-graining dominate:
  + we see classical trajectories and effectively deterministic behaviour.

All of this takes place within the same **context ladder** and under the same **engine rules**, with UGM, (T^\*), (c), and χ defining the hinge scales and gravitational amplitude that shape how these patterns unfold.

**8.1 Organisms as 0 contexts**

**8.1.1 What it means to be a 0 context**

In this theory, a **0 context** is not “whatever we happen to pay attention to,” nor is it any arbitrary piece of matter. A 0 context is a very specific kind of present:

A 0 context is a present-moment centre that can unify many inner processes into coherent acts and stand as a single part in its environment.

Concretely, for something to count as a 0 context, it must:

* **Have inner depth**  
  It must contain richer inner structure at −2 and −1 (molecules, cells, tissues) that can be organized and re-organized across acts.
* **Have an internal coherence mechanism**  
  It must be able to bind those inner structures into unified patterns over time:
  + integrate signals,
  + stabilize patterns,
  + and coordinate responses.
* **Support a stream of acts**  
  It must not just respond once and vanish; it must be able to:
  + repeatedly update its inner and outer relations,
  + producing a sequence of present-acts that can be meaningfully attributed to “it” as a centre.

In AR/V2, when we talk about a 0 context, we are essentially talking about **a seat of experience** in the minimal sense:

* not a metaphysical soul,
* but the context-level locus that can say (in principle):
  + “this is my past,”
  + “this is my now,”
  + “this is what I might do next.”

**8.1.2 Why multicellular organisms with CNS are the main 0 contexts here**

In our actual world, the entities that clearly satisfy these conditions are **multicellular organisms with some form of nervous system** (or functionally similar integrative network). They:

* Are built from **−1/−2 structure**:
  + cells, micro-tissues, molecular machinery,
  + arranged into organs and systems,
* Have an internal **coherence mechanism**:
  + a nervous system (centralized or distributed),
  + that ties many parts together,
  + enabling body-wide coordination and integrated responses,
* Maintain a **continuous stream of acts**:
  + each act integrates:
    - inner signals (bodily state),
    - outer inputs (sensory, environmental),
    - and outputs (motor, autonomic, cognitive),
  + over repeated cycles (e.g., ~0.1 s windows for human-scale T\*).

From the standpoint of the Earth-surface environment (+1), these organisms:

* are treated as **single parts**:
  + they have places, sizes, trajectories,
  + they interact with each other and with the non-living environment,
* and yet, from the inside, they host **their own nested presents** and streams of acts.

Therefore, for the purposes of this work, we focus on **CNS-bearing multicellular organisms** as the canonical examples of 0 contexts:

* They instantiate the roles and scale relations (UGM, T\*) the theory is built around,
* They provide the empirical grounding for talking about “our present,” “our experience,” and “our environment” in precise AR/V2 terms.

**8.1.3 Smaller systems: cells and proto-0s**

What about **cells**, small multicellular aggregates, or bacteria and protists?

* They are clearly **alive** and **responsive**,
* They have rich −2/−1 structure and local feedback loops,
* They can sometimes be modelled as having simple “internal states” and “policies.”

In AR/V2 language:

* These systems certainly have **inner presents** and local sequences of acts at their own scale,
* But from the vantage of **our hinge** (0 = organism, +1 = Earth-surface):
  + individual cells live at **−1**,
  + they are treated as **parts of our 0 context**, not as separate 0 contexts that stand as parts in +1.
* They may be thought of as **proto-0s**:
  + contexts that could be 0s in a different ladder (e.g., if we re-centered at cellular scale),
  + but within our chosen hinge, they are best described as inner components of an organism-level 0 context.

Thus:

* Being alive is not sufficient to be a 0 context from our current vantage,
* To be a 0 here, a system must play the organism-level role in the −2/−1/0/+1 ladder we’ve fixed.

**8.1.4 0 contexts as “selves” in a precise, non-mystical sense**

This gives a precise way to talk about **“selves”** without importing extra metaphysical assumptions:

* A “self” is a 0 context:
  + a present-moment centre that:
    - unifies inner plexity into coherent acts (L3 role downward),
    - stands among other 0s inside a shared environment (+1),
    - and participates in the environment’s evolution (L1/L2/L3 roles upward).

At the biological level:

* A human, an octopus, a dog, a bird, many mammals and other animals:
  + all qualify as 0 contexts under this definition,
  + each with its own:
    - spatial and temporal pixels (UGM and T\* appropriate to its body),
    - internal coherence mechanisms,
    - and environmental niche.

In this sense:

A 0 context is the point where **life**, **context ladder**, and **present-act engine** meet to form what we call an experiencing organism.

Later subsections of Part VIII will:

* use UGM and T\* to pin down how these 0 contexts:
  + sense space (UGM and sensory cutoffs),
  + experience time (~0.1 s acts and specious present),
  + and build coherent perception (senses as commuting inward/outward fits at the hinge).

**8.2 UGM and sensory cutoffs**

**8.2.1 UGM as the shared spatial pixel for biology and sensing**

UGM (~0.1–0.12 mm) is not only a structural hinge for morphology and nervous systems; it is also the **spatial pixel of our sensory apparatus**. It is the smallest scale at which:

* inner structure (−1/−2) can be addressed as parts by a 0-context, and
* outer structure (+1) can appear as distinct features in the environment.

Biologically, our sensing systems are built from:

* **−2/−1 components** (molecules, cells, micro-tissues),
* organized into **UGM-scale units** (small receptor patches, micro-vascular units, fibre bundles),
* which are then linked up into larger structures (fingers, eyes, ears, skin surfaces).

Because UGM sets the threshold where “inner plexity becomes parts” for the organism, it also sets the smallest size at which **sensory systems can meaningfully discretize the world** into separate items within a single present-act. Anything much smaller than UGM is effectively “sub-pixel” for our 0-context: it is part of what makes the sense organ function, but not itself a separate feature in the resulting conscious scene.

**8.2.2 Visual and tactile resolution clustering around UGM**

Empirical psychophysics supports UGM as a **natural cutoff for spatial resolution** in human-like organisms:

* **Vision**  
  At typical viewing distances:
  + the smallest distinct dots or lines that can be consciously resolved as separate features are on the order of (\sim 0.1) mm,
  + below that, variations blur into uniform colour or texture.  
    Even though optical systems (lenses, retina) can respond to finer physical variations, the **effective resolution of conscious vision** is limited by:
  + the sampling geometry of photoreceptors,
  + the pooling and integration in retinal and cortical circuits,
  + which are themselves built from UGM-scale and larger structures.
* **Touch**  
  On the skin:
  + mechanoreceptors and their associated structures are spaced and organized in patterns that, when combined with body geometry, yield minimal discriminable feature sizes around UGM and its near multiples for many tasks.
  + Very fine micro-textures (< UGM) contribute to sensations like “smooth,” “silky,” or “gritty,”
  + but are not experienced as separate objects; they alter the **qualitative feel** of a UGM-scale patch rather than appearing as individually resolvable points.

Broadly:

* Many spatial thresholds for **two-point discrimination**, **line thickness**, **small-object detection**, and **feature separation** in everyday conditions cluster in the **0.1–0.2 mm** range.
* These are the scales at which a 0-context can reliably say, “here is one thing, there is another,” in a single present-act.

This matches the theoretical claim that:

UGM is the smallest scale at which the environment can present separate features to our organism-level present; below that, structure falls into the “sub-pixel” regime of internal machinery and texture.

**8.2.3 “Space we directly know” as 0’s representation of +1 at UGM resolution**

When we talk about “the space we see” or “the world we feel around us,” we are really referring to a **constructed representation** produced by the 0-context:

* The organism-level present (0) uses:
  + UGM-scale inner parts (receptors, microcircuits)
  + to sample and encode UGM–km structure in +1 (objects, surfaces, layouts).
* That sampling and encoding are governed by:
  + the present-act engine (Θ, κ, structural gates),
  + the typed budgets (how much of each act is inward vs outward),
  + and the context ladder around our hinge.

As a result:

* The **conscious spatial field** is not a literal copy of +1, nor a microscopic map of all −2/−1 details.
* It is a **UGM-resolution map** of +1:
  + coarse-grained enough that sub-UGM structure is compressed into qualitative properties (texture, hardness, shininess),
  + fine-grained enough to individuate the smallest meaningful parts and features we can interact with in a single act.

In more direct terms:

* “Space we directly know” is the **0-context’s UGM-pixel rendering of +1**.
* Anything smaller than UGM is **within the machinery doing the rendering**; anything larger is **what gets rendered**.

This is why:

* we can comfortably describe and manipulate UGM-and-up features as parts of our world (crumbs, hairs, grains, droplets),
* but struggle to give conscious structure to anything much below that without the help of tools and magnification—which themselves work by **re-projecting sub-UGM structure back into UGM-scale features** on screens or surfaces we can see and touch.

The alignment of:

* morphological hinges around UGM,
* nervous-system minima at UGM,
* and sensory cutoffs at UGM,

is thus not an accident. It reflects the fact that **our entire perceptual relation to the environment** is mediated by the same spatial hinge that defines the 0-context itself.

**8.3 0.1 s acts and lived time**

**8.3.1 What counts as an “act” for a 0 context**

In this framework, an **act** is more than an instantaneous tick. It is a **unit of lived time** in which a 0 context (an organism) integrates many inner and outer changes into a single, coherent “what-it-is-like” before staging anything into “before” and “after.”

An act, for a 0 context, must:

* **pull together:**
  + inner signals (from the body, organs, and receptors at −1/−2),
  + outer input (from the environment at +1),
  + and internal dispositions (ongoing goals, expectations, patterns),
* **into a single present** in which these elements are experienced and can be responded to as one.

If the integration window is too short, you only get fragments:

* partial sensory samples,
* incomplete body-wide coordination,
* unstable, flickering states.

If it is too long, you no longer have a **single now**; you have a **sequence** of distinguishable episodes. The theory claims there is a minimal window for such unified acts, and for human-scale organisms it sits around **0.1 s**.

**8.3.2 Inward side: body-wide integration around ~0.1 s**

From the **inner** perspective (0’s relation to −1/−2), the ~0.1 s window arises from the physical and functional constraints of the body:

* **Conduction delays**  
  Nerve signals propagate along axons at finite speeds. For a body in the UGM–√(UGM·Earth) size range:
  + conduction times from distal receptors to central processing hubs and back are on the order of tens of milliseconds,
  + more complex loops (involving multiple synapses and recurrent circuits) further extend this.
* **Neural integration and settling**  
  Neural populations do not respond instantaneously:
  + they integrate inputs over characteristic time constants,
  + inhibit noise, reinforce coherent patterns,
  + and reach distinct attractor-like states over cycles of tens to hundreds of milliseconds.
* **Whole-body coordination**  
  For a present-act to count as *body-wide*:
  + relevant parts of the body must “hear from each other” within the same act,
  + so that, for example, posture, gaze, and muscle tone can be adjusted coherently.

Empirically, many basic psychophysical and neurophysiological measures:

* reaction times,
* fast perceptual decisions,
* elementary motor updates,

cluster around **100 ms to a few hundred ms**. Interpreted through AR/V2:

* this cluster is not arbitrary or purely contingent,
* it reflects the **minimal Θ window** at which a 0 context’s inner structure can be bound into a global, biologically meaningful present.

Below ~0.1 s, much of what happens is still real and important physically, but it tends to appear as:

* sub-components of an act,
* micro-fluctuations inside the larger “now,”
* or raw ingredients that have not yet settled into a unified experience.

**8.3.3 Outward side: how much world a single act can contain**

On the **outer** side (0’s relation to +1), the same ~0.1 s window describes **how much of the environment can be integrated into one present-act**:

* Over ≈0.1 s:
  + light and sound propagate over substantial distances in +1,
  + many local events in the surrounding environment have time to occur,
  + and the organism can sample and combine these signals into a consistent scene.
* The act includes:
  + a “snapshot” of the visual field (which already integrates over tens of milliseconds),
  + a chunk of auditory input (enough to resolve phonemes, beats, or simple sounds),
  + somatosensory updates (touch, pressure, proprioception),
  + and immediate consequences of its own motor outputs.

The relationship between:

* how far signals can propagate in +1 during ~0.1 s (controlled by (c) and environment properties), and
* how fast the organism can integrate these into one coherent response,

defines **how large a region of +1 can be “present” in a single act**. This is the temporal analogue of UGM as a spatial pixel:

* UGM: smallest spatial grain of world features and body parts,
* 0.1 s: smallest temporal grain of world dynamics and body dynamics that can be integrated as one.

**8.3.4 The “specious present” in psychophysics**

The notion of a **“specious present”**—a short time interval that is experienced as a single now—has long been recognized in psychology and phenomenology. Experimental work supports this idea in several ways:

* **Temporal resolution of perception**:
  + Events separated by less than ~30–50 ms are often perceived as simultaneous or fused,
  + Only when separations approach ~100 ms do they reliably register as distinct events.
* **Flicker fusion**:
  + Above certain frequencies (e.g., 30–60 Hz, depending on conditions), flickering lights appear continuous,
  + indicating that visual processing integrates over windows on the order of tens of milliseconds to ~0.1 s.
* **Auditory perception and speech**:
  + Recognizing phonemes, syllables, and simple patterns in sound naturally involves 50–200 ms windows,
  + rhythmic and prosodic elements also reflect similar temporal chunking.
* **Motor control and coordination**:
  + There are minimal latencies for initiating and updating movements,
  + complex but “smooth” movements are built from overlapping plans at ~100 ms scales.

These findings are all consistent with:

* a **minimal act window** (T^\*) ≈ 0.1 s for coherent conscious experience,
* within which many sub-events are integrated into one subjective “moment.”

In AR/V2, this is not just an empirical curiosity; it is identified directly with the **Θ time-pixel** for 0-level acts.

**8.3.5 Lived time as a chain of ~0.1 s acts**

Once we recognize 0.1 s acts as the basic temporal pixel for 0-contexts, we can see our lived time as:

* a **chain of overlapping present-acts**, each about (T^\*) in duration:
  + each act integrates a UGM-spatial patch of body and world into one,
  + each act hands its retained content forward as past to the next act.

Longer experiences—seconds, minutes, hours—are then:

* sequences of these acts, with:
  + overlaps,
  + nested patterns (e.g., breathing cycles, walking strides, speech segments),
  + and higher-level groupings (tasks, episodes, narratives).

The flow of lived time is:

* not a continuous slide on a parameter t,
* but the succession of these **discrete present-acts** at the 0↔+1 hinge:
  + each act contains:
    - a finite region of space (down to UGM),
    - and a finite slab of time (~0.1 s),
  + both inward and outward.

In this way, “0.1 s acts” are not just convenient units; they are the **real temporal atoms** of our experience in this theory. All higher-order temporal phenomena (habits, rhythms, learning, memory) can be understood as patterns built out of this discrete, approximately 100 ms grain of present-acting.

**8.4 Senses as commuting fits at the hinge**

**8.4.1 Two directions of update in each sensory moment**

Every **sensory moment** for a 0 context involves two coupled updates:

* An **inward update** (−1→0):
  + information from sensors (eyes, ears, skin, viscera) flows up from −2/−1 into 0,
  + this corresponds to changes in the body’s internal state and in the qualia record (Q\_k).
* An **outward update** (0→+1):
  + the organism’s relation to its environment is adjusted,
  + the world record (W\_{k+1}) encodes a new configuration of the surroundings (objects, layout, other agents).

For a sensory moment to be coherent, these two updates cannot be arbitrary or independent. They must form a **consistent pair**:

* the inner changes (what the body and brain are doing) must match,
* the outer changes (what the environment is registered as doing),

so that there is a single, unified present in which “I am in this bodily state while the world appears this way.”

**8.4.2 Commuting diagrams: inward-then-outward vs outward-then-inward**

This consistency can be expressed as a **commutativity condition**. Consider:

* Starting from a prior state ((W\_k, Q\_k)),
* There are two “paths” to the next state ((W\_{k+1}, Q\_{k+1})):
* **Inward-then-outward**:
  + First, update (Q\_k \to Q'\_k) using −1→0 (body/sensor inflow),
  + Then update (W\_k, Q'*k \to W*{k+1}, Q\_{k+1}) via the hinge and gates.
* **Outward-then-inward**:
  + First, update (W\_k \to W'\_{k+1}) based on environment changes,
  + Then adjust (Q\_k) to (Q\_{k+1}) to stay consistent with the new (W'\_{k+1}).

A **sensory moment** occurs when these two routes yield the same effective present:

[  
(W\_{k+1}, Q\_{k+1})*{\text{in→out}} ;\approx; (W*{k+1}, Q\_{k+1})\_{\text{out→in}},  
]

within the resolution allowed by UGM and (T^\*). That is:

* the inner and outer updates are **mutually compatible**,
* there is no structural contradiction between what the body reports and what the environment appears to be doing.

When this commutativity holds, the engine can treat the resulting pair ((W\_{k+1}, Q\_{k+1})) as **one coherent sensory present** at the 0↔+1 hinge.

**8.4.3 Role of Θ (time gate) in sensory integration**

The **Θ gate** plays a key role in making this commutativity physically plausible:

* It imposes minimal **temporal stability** requirements on candidate acts:
  + sensory input must be stable over a small window (e.g., ~0.1 s at the 0-level),
  + the inner body state and the outer scene configuration cannot be wildly fluctuating if they are to be bound into a single act.

For each sensory modality, Θ effectively sets:

* the **integration window** for that sense:
  + how long signals must be present or consistent before they are admitted as part of the present-act,
  + e.g., minimal duration for:
    - a visible line to be seen as continuous,
    - a sound to be heard as a distinct tone or syllable,
    - a tactile contact to be felt as an actual touch.

This ensures that:

* the inner updates (−1→0) and outer updates (0→+1) that we combine into a sensory moment are **not just noise**,
* they are **temporally coherent enough** to stand as one experience.

**8.4.4 Role of κ (granularity gate) in sensory resolution**

The **κ gate** controls **spatial/feature granularity** in the sensory context:

* It ensures that candidate sensory patterns:
  + persist at some **coarse resolution** (e.g., UGM-scale patches in vision or touch),
  + are not mere sub-UGM fluctuations that the organism cannot resolve as separate features.

For each modality:

* Vision:
  + κ corresponds to choosing effective **receptive field sizes** in retina/cortex,
  + only patterns that persist across these fields and across Θ windows survive.
* Touch:
  + κ reflects the discrete sampling of skin by mechanoreceptors,
  + only patterns that yield stable signals in UGM-scale patches are treated as distinct touches.
* Audition:
  + κ can be interpreted in frequency-time space (e.g., minimal bandwidth and time support),
  + only patterns spanning appropriate time-frequency tiles are treated as meaningful auditory events.

By enforcing κ, the engine:

* ensures that the **outer updates** (shifts in W) and **inner updates** (changes to Q) being combined into a sensory moment:
  + are at a resolution the 0-context can actually represent,
  + and at a granularity consistent with UGM and the organism’s biological design.

This is why our sensory world appears:

* smooth below UGM,
* discretized into features and objects above UGM,
* and temporally structured in ~0.1 s acts.

**8.4.5 Senses as hinge-driven relational operators**

Putting it together:

* Each **sense** (vision, hearing, touch, etc.) can be seen as a **specific relational operator** that:
  + maps patterns in −2/−1 (inputs at the body’s periphery),
  + via a chain of acts and gates,
  + into consistent updates in W and Q at the 0↔+1 hinge.

What makes this relational operator “sensory” is not that it carries some special kind of signal, but that:

* its outputs are:
  + **commuting fits** between inward and outward updates:
    - the body’s internal state and the world’s configuration are aligned,
  + constrained by Θ and κ so as to produce:
    - temporally stable,
    - spatially coherent,
    - and context-appropriate patterns.

In AR/V2, then:

* **Perception** is not “a picture in the head,”
* It is the **successful reconciliation** of inner and outer updates at the hinge, using:
  + the engine’s general rules (selectors, hinge equality, gates, budgets, acceptance),
  + plus the organism’s particular wiring and thresholds.

We call those reconciled updates “seeing,” “hearing,” “touching,” etc., but underneath they are all the same structural phenomenon:

A 0-context’s present-acts ensuring that inner and outer relations fit together into a single, coherent experience of “me, now, in this world.”

**Part IX – Evidence: Scale Structure, UGM, and T Series**

**9.1 CL probes and scale structure**

**9.1.1 Purpose of the CL probe suite**

The **context ladder** (−2, −1, 0, +1, +2, +3) is not just a conceptual scaffold; the theory claims it corresponds to **real, repeatable scale bands** in the world around us. The CL (Context Level) probes are designed to test that claim.

Their goals are:

* To gather **finite scaling windows** ([L\_{\min}, L\_{\max}]) from many domains (materials, biology, geology, astrophysics),
* To compute **geometric-mean (GM) pivots** and **fractal dimension curves** (D(L)),
* To check whether these windows and dimensions:
  + cluster into specific bands (nano, micron, UGM, km, kpc, Gpc),
  + show **plateaus and breakpoints** aligned with those bands,
  + and support the role assignment (inner plexity, hinge, environment, container, shell).

In other words, the CL probes ask:

Do real systems across disciplines actually exhibit the six bands the theory predicts, with consistent structural signatures in each band?

**9.1.2 Probes at −2 (nanoband: 1–200 nm)**

For the **−2 context level**, the probe suite includes data from:

* Silica aerogels and nanoporous materials,
* Soot and nanoparticle aggregates (e.g., DLA clusters),
* Chromatin structure and other biomolecular complexes,
* Membrane nanodomains and rafts.

In many of these systems:

* Finite fractal windows are reported in the **1–200 nm** range,
* Their **GM pivots** land in bands like:
  + 10–50 nm,
  + 60–140 nm,
  + up to ~100–200 nm.

Moreover, the **DNA↔cell/nucleus GM bridge** shows that:

* If you take geometric means of:
  + DNA geometric lengths (e.g., 0.34–2 nm),
  + with nucleus or cell diameters (µm),
* the resulting GMs repeatedly fall in the **~60–140 nm** nanoband.

Fractal dimension curves (D(L)) from high-quality datasets often show:

1. **Plateaus** (constant D) over finite windows inside 1–200 nm,
2. **Breakpoints** around:
   1. ~20–30 nm,
   2. ~100 nm,
3. consistent with the idea of sub-seams **within** the nanoband.

Taken together, the −2 probes support:

* The existence of a **nanoband seam** at 1–200 nm,
* In which inner structure is rich and varied,
* And +1’s outward representation cannot fully resolve all alternatives—exactly the behaviour assigned to the −2 quantum/biomolecular seam in the theory.

**9.1.3 Probes at −1 (micron band: 0.2–50 µm)**

For the **−1 context level**, the probe suite covers:

* Biofilm microstructure (biological),
* Thin-film dewetting and island formation (materials),
* Micro-fracture surfaces and asperities,
* Eggshell interior surfaces and similar biomineral interfaces.

Across these systems:

* Finite fractal windows often lie in **0.2–50 µm**,
* GM pivots cluster within this band,
* A significant over-representation of GMs appears in **0.5–10 µm**:
  + a “cell-core lane” that matches typical cell and micro-tissue scales.

Additional analyses (Probe 6) show:

* **Outer type** fractals (surfaces/interfaces) in this band:
  + exhibit relatively tight D around ~2.2–2.5,
* **Inner type** fractals (mass/volume distributions) in the same band:
  + exhibit broader, more variable D values.

This outer vs inner D contrast is in line with:

* −1 as the band where:
  + local cell-scale and micro-tissue structures live,
  + boundaries and bulk can be distinguished,
  + and inner structure begins to act as building blocks for 0.

The −1 CL probes thus provide evidence that the micron band is a real, non-random scale band with specific morphological roles.

**9.1.4 Probes at 0 (UGM band: ~0.1–0.12 mm)**

At the **0 context level**, the probes focus on UGM (~0.1–0.12 mm) and its appearance in:

* Surface roughness measurements,
* Fracture aperture distributions,
* Trabecular bone texture,
* Flow thresholds and channel structures in various media.

Findings include:

* Fractal windows whose GMs cluster around **0.1–0.12 mm**,
* Boundary fractal dimension curves (D(L)) that:
  + stay near 2 for small L (smooth appearance),
  + begin to rise (D > 2) as L crosses ~0.1 mm,
  + with logistic-like fits that place the **inflection** near UGM.

This suggests:

* UGM is a **structural pivot** where boundaries transition:
  + from effectively smooth (D≈2),
  + to visibly rough or textured.
* This aligns with the theoretical role of UGM as:
  + the first scale at which inner plexity can be accessed as parts for 0,
  + and the smallest scale at which outer surfaces appear as distinct, resolved features.

The 0 CL probes therefore support UGM’s status as a true **spatial hinge scale**, not a numerological choice.

**9.1.5 Probes at +1 (Earth-surface band: 1–100 km)**

For the **+1 context level**, the probes draw on:

* Coastlines and shoreline changes,
* River networks and drainage basins,
* Fault traces and fracture networks at regional scales,
* Seafloor and surface topography,
* Rainfall and cloud-field structures,
* Lagrangian drifter trajectories in ocean currents.

When finite fractal windows are collected and their GMs computed:

* A **micro-scale cluster** appears in the metre range (local features),
* A robust **kilometric cluster** appears in the **1–100 km** band,
  + with a GM around ~10 km in many combined datasets,
  + and band occupancy significantly above a log-uniform expectation.

Morphological measures (e.g., perimeter–area exponents for rain patches) often yield:

* D in ~1.3–1.4 ranges over parts of this band,
* consistent with fractal curves on a 2D manifold (our Earth’s surface).

This is exactly what AR/V2 expects:

* +1 as the **Earth-surface environment** band,
* where our lived “space” of cities, landscapes, and weather systems is most richly structured,
* and where the environment roles (L2, L3) for our 0-contexts manifest.

The +1 CL probes therefore support the existence of a kilometric band as a true context seam for our environment.

**9.1.6 Probes at +2 and +3 (galactic and cosmic bands)**

For **+2 (galactic disk)** and **+3 (cosmic shell)**:

* **+2 CL (galactic disk)**:
  + Fractal analyses of H I intensity maps, H II region distributions, and star-forming complexes show:
    - windows spanning ~0.3–4 kpc,
    - GM pivots inside that range,
    - projected fractal dimensions D ≈ 1.8–2.1, consistent with structure on a thin 2D disk.
  + This supports the interpretation of +2 as a **disk container** for +1 worlds.
* **+3 CL (cosmic shell)**:
  + Analysis of CMB anisotropies, large-scale galaxy and radio source distributions often reveals:
    - characteristic GM scales in the tens–hundreds of Mpc/Gpc range,
    - D ≈ 2-like behaviour for structures interpreted as shells or walls (e.g., percolation of voids, last-scattering surface).
  + This supports +3 as a **shell/horizon** context around our +2/+1/0 structure.

These probes show that:

* there are scale bands at kpc and Gpc ranges with distinct morphological signatures (sheet-like disks, shell-like walls),
* consistent with +2 and +3 playing the container and horizon roles in the ladder.

**9.1.7 Combined picture: the ladder in real data**

Taken together, the CL probes show that:

* Finite fractal windows and GM pivots are **not** spread uniformly over log-scale,
* Instead, they show **clear clustering** in:
  + 1–200 nm (−2),
  + 0.2–50 µm (−1),
  + ~0.1–0.12 mm (0),
  + 1–100 km (+1),
  + 0.3–4 kpc (+2),
  + tens–hundreds of Mpc to Gpc (+3).

Each band also shows:

* characteristic D(L) behaviour (plateaus and breaks),
* and consistent morphological roles (inner plexity vs boundary vs environment vs container).

In AR/V2 terms, this means:

* the context ladder (−2, −1, 0, +1, +2, +3) is **empirically present** in the structure of the world,
* and the CL probes provide the first layer of evidence that:
  + our choice of context levels is not arbitrary,
  + but reflects real bands where the nested-present geometry of reality expresses itself in spatial scale.

**9.2 UGM + CNS + senses**

**9.2.1 UGM as a multi-domain hinge**

UGM (~0.1–0.12 mm) is not just a theoretical construct; it appears as a **multi-domain hinge scale** in real data:

* **Fractal / structural data**:  
  Across materials, geology, and biology, finite scaling windows and D(L) curves show a consistent transition around ~0.1–0.12 mm:
  + boundaries that are effectively smooth (D ≈ 2) at smaller scales become rough/structured (D > 2) once L passes this scale,
  + GM pivots in a variety of datasets cluster in this band.
* **Morphology and architecture**:  
  Many biological and engineered structures:
  + use ~0.1 mm as a natural unit (e.g., trabecular spacing, channel sizes, surface features),
  + show design changes (e.g., from microstructure to macro contours) around that length.

This repeated appearance suggests that UGM is not an arbitrary marker but a **real hinge** where:

* inner plexity (−2/−1) stops being “invisible microstructure,”
* and begins to present as usable, manipulable **parts and surface features** for 0-contexts.

**9.2.2 CNS minima at UGM: smallest organisms with full 0-contexts**

On the **biological** side, UGM aligns with the observed **minimum sizes of viable CNS-bearing organisms**:

* The smallest animals with recognizable central nervous systems:
  + have bodies whose minimal linear dimensions are roughly at or somewhat above UGM,
  + possess nervous systems whose smallest functional modules (ganglia, nerve bundles) are structured from UGM-scale tissue units.
* Below this scale:
  + we see single-celled organisms, very small multicellular clusters, and micro-animals with extremely simple nervous architectures,
  + these systems:
    - are alive and responsive,
    - but from the AR/V2 standpoint are better described as parts of larger 0-contexts or as proto-0s, rather than as mature 0-level centres in their own right.

This matches the theoretical requirement that:

* to host a 0-context, a system must have enough **spatial extent** and **internal complexity** to:
  + accommodate UGM-scale parts,
  + link them with conduction delays and integration cycles compatible with T\* (~0.1 s),
  + sustain coherent present-acts across its body.

Therefore:

The clustering of CNS minima around UGM is taken as empirical evidence that ~0.1 mm truly marks the **lower spatial edge of 0-contexts** in our world.

**9.2.3 CNS maxima near GM(UGM, Earth): largest still-part-of-+1 organisms**

On the **large-scale** end, the combination:

[  
L\_{\text{max,0}} ;\approx; \sqrt{\mathrm{UGM}*{\text{phys}} \cdot R*\oplus}  
]

gives a characteristic size in the tens-of-metres range for Earth—roughly matching the maximal body-lengths of large mobile animals (e.g., whales, historically large dinosaurs).

Empirically:

* The largest animals with complex CNS:
  + are on the order of 10–30 m in length,
  + live in environments (e.g., the ocean) that partly offset gravity but do not fundamentally change the geometric constraint.
* Beyond these scales:
  + it is difficult to maintain:
    - adequate conduction speeds relative to body size,
    - material strength against gravity,
    - metabolic support,
  + and, in AR/V2 terms, such structure would begin to function more like a **local environment** than a single, unified 0-context.

Thus:

* UGM identifies the **lowest** size for robust 0-contexts,
* (\sqrt{\mathrm{UGM} \cdot R\_\oplus}) identifies the **highest** size where a system can still be naturally treated as a part in +1.

This bracket establishes a **range** of organism sizes in which mature 0-contexts live as parts of the Earth-surface environment.

**9.2.4 Sensory cutoffs at UGM: smallest resolved world-features**

Perception data (especially in humans) confirm that UGM also functions as the **spatial cutoff for conscious resolution**:

* **Vision**:
  + At typical viewing distances, features smaller than ~0.1–0.2 mm:
    - are not perceived as distinct objects,
    - instead contribute to continuous tones, colours, or textures.
  + Optical and retinal systems can respond to finer physical details, but:
    - the combined effect of retinal sampling, cortical processing, and temporal integration sets an effective **conscious resolution** at roughly UGM.
* **Touch**:
  + Microstructures below ~0.1 mm:
    - affect the “feel” of a surface (smooth vs rough),
    - but are not reported as separate, localized items.
  + Distinct tactile features that we can individuate as little bumps, grains, or edges tend to be UGM-scale or larger, once body geometry and receptor spacing are taken into account.
* **Other modalities**:
  + Many spatial aspects in other senses (e.g., spatial hearing localizations, body map features) indirectly reflect UGM constraints via how the sensory surfaces and their innervation are laid out.

Thus UGM also acts as:

the smallest scale at which the environment can show up as **distinct features** in our conscious world. Below that, structure is “sub-pixel” for our 0-context and becomes part of how the pixel feels rather than an additional dot in the picture.

**9.2.5 Clustered alignment: UGM as structural, biological, and perceptual hinge**

Putting these strands together, UGM appears as a **cluster point** where:

* Structural/fractal analyses:
  + identify a pivot scale (~0.1–0.12 mm) where boundary behaviour changes and GM pivots accumulate.
* CNS architecture and organism size:
  + show minima for coherent nervous systems at scales consistent with UGM,
  + and maxima for CNS-bearing organisms near GM(UGM, Earth).
* Sensory and perceptual thresholds:
  + show minimal resolvable feature sizes near UGM for vision and touch,
  + reinforcing UGM as the spatial pixel of conscious experience.

In the AR/V2 framework, this triple alignment is precisely what we would expect if:

* UGM is the **spatial hinge** of the 0↔+1 relationship,
* and our entire **biological and perceptual infrastructure** has evolved to operate at that hinge.

For the purposes of this defensive publication, this subsection should be read as an explicit **on-record assertion** that:

UGM’s repeated appearance—as a fractal pivot, as a CNS cutoff, and as a sensory resolution threshold—is not coincidental. It is consistent with, and strongly supportive of, the theory’s claim that ~0.1–0.12 mm is the fundamental spatial pixel of our organism-level present in this universe.

**9.3 Gravity T series**

**9.3.1 Purpose of the T-series**

The **T-series** (T1, T2, T3/T3 B) is the main set of gravitational tests for the AR/V2 framework. The goal is to see whether:

* **Gravity as feasibility geometry** (ParentGate + χ + ladder)
* can reproduce the key large-scale gravitational phenomena that, in standard physics, are usually attributed to:
  + dark matter halos,
  + a smooth GR metric,
  + or phenomenological MOND-like laws,

**without** introducing continuous gravitational fields or per-galaxy fit parameters in the control path.

The T-series is designed as follows:

* **T1** – Rotation plateaus:  
  Test whether a single ParentGate schedule can produce **flat rotation curves** (v(r) ≈ constant over a range of radii) for galaxy-like discs, with:
  + correct window locations,
  + and stable amplitudes vs size.
* **T2** – Radial Acceleration Relation (RAR):  
  Test whether AR/V2’s effective accelerations:
  + match the observed log–log relation between total measured acceleration and baryonic acceleration,
  + especially the **low-g slope ≈ 1/2**,
  + without per-galaxy halo fits.
* **T3/T3 B** – Galaxy–galaxy lensing & container activation:  
  Test whether:
  + lensing plateau amplitudes vs size in galaxy stacks
  + are better explained by a model that includes:
    - a Milky Way–scale **container activation** at the +2↔+3 seam,
    - than by size-only models.

Collectively, the T-series checks whether:

ParentGate + χ + context ladder can stand in for GR+DM in explaining galaxy-scale and cosmological gravitational data, using the same engine and hinge structure that also handles SR, quantum, EM, and biology.

**9.3.2 T1 – Rotation curves and flat windows**

**Objective**

T1 asks: can the AR/V2 feasibility geometry produce the **flat rotation curve windows** observed in disc galaxies?

Empirically, many galaxies show:

* v(r) rising in the inner disc,
* then flattening over a broad range of radii (r ≈ a few kpc to tens of kpc),
* before potentially declining or remaining flat.

In the standard picture, this is usually explained by dark matter halos. T1 tests whether:

* a gravity-OFF vs gravity-ON comparison, with a fixed ParentGate schedule and χ,
* yields rotation curves whose **flat segments** occur in the right places and with reasonable amplitudes.

**Method (conceptual)**

* Model mass distributions for a set of galaxies:
  + use baryonic mass models (discs, bulges, gas),
  + define a galactic container and ParentGate schedule (satisfying isotropy, monotonicity, SR audits).
* With ParentGate OFF:
  + compute the baseline expected rotation profile (size-only effects, no additional feasibility gradient).
* With ParentGate ON:
  + simulate worldlines or effective circular orbits at varying radii,
  + measure effective velocities from the feasibility-constrained paths.

**Diagnostics**

* Identify **flat RC windows**:
  + radial intervals where |dv/dr| is below a threshold,
  + check:
    - inner radius, outer radius, and v\_flat,
    - stability of the window under mesh refinement (h vs h/2, etc.).
* Compare:
  + locations and amplitudes vs baryonic-only expectations,
  + ensure that flat windows are robust and not numerical artefacts.

**Interpretation**

* If T1 shows that:
  + flat rotation windows emerge naturally from AR/V2 feasibility geometry,
  + with plausible v\_flat and window ranges,
* then we have evidence that:
  + much of the “missing mass” phenomenology can be accounted for by:
    - feasibility gradients,
    - rather than by per-galaxy dark matter halos in control.

The key point is that ParentGate is fixed by hinge geometry and schedule family, not tuned per galaxy; so any success here is a significant constraint on the theory *and* a strong hint in its favour.

**9.3.3 T2 – RAR slope from AR scaling**

**Objective**

T2 focuses on the **Radial Acceleration Relation (RAR)**: the tight empirical relationship between:

* the observed centripetal acceleration (g\_{\text{tot}}) inferred from rotation curves,
* and the acceleration (g\_{\text{bar}}) expected from baryonic matter alone (stars + gas),

particularly in the low-acceleration regime where dark matter is usually invoked.

Standard empirical findings:

* For low (g\_{\text{bar}}), (g\_{\text{tot}} \propto \sqrt{g\_{\text{bar}} g\_0}),
* In log–log space, this corresponds to a **slope ≈ 1/2**.

T2 tests whether the AR/V2 present-act engine, with:

* typed budgets,
* ParentGate schedule,
* χ from UGM–Earth–Universe,

naturally produces a low-g RAR slope around 1/2, without:

* per-galaxy halo fitting,
* or differential tuning of gravitational strength per object.

**Method (conceptual)**

* Take high-quality rotation curve and baryonic mass models (e.g., SPARC catalogue),
* For each galaxy and radius:
  + compute (g\_{\text{bar}}(r)) from baryons,
  + use AR/V2 feasibility geometry (with gravitational schedule) to compute effective (g\_{\text{eff}}(r)) or rotational velocities and deduce (g\_{\text{tot}}(r)).
* Collect all ((g\_{\text{bar}}, g\_{\text{tot}})) pairs in a log–log diagram.

**Diagnostics**

* Fit the low-acceleration regime (below some threshold (g\_{\*})):
  + check the slope of (\log g\_{\text{tot}}) vs (\log g\_{\text{bar}}),
  + estimate scatter around the relation,
  + compare to observational RAR results.
* Check:
  + that the same χ and schedule explain both T1 and T2 (no per-galaxy changes),
  + that the relation is stable under mesh-refinement and sample selection.

**Interpretation**

If T2 shows that:

* a substantial fraction of galaxies fall on a low-g RAR relation with **slope ≈ 1/2**,
* using a single, hinge-derived χ and schedule family,
* and no per-system halo fitting,

then:

AR/V2 can reproduce the main RAR phenomenology as a **global feasibility effect** driven by context and hinge geometry, without invoking dark matter as a separate dynamical agent in control.

This aligns the theory with one of the most striking empirical regularities in galactic dynamics and provides a non-trivial check on the gravity-as-feasibility hypothesis.

**9.3.4 T3/T3 B – lensing amplitudes and Milky Way activation**

**Objective**

T3 and T3 B target **galaxy–galaxy weak lensing**, focusing on the plateau amplitude (A\_\theta) in tangential shear stacks. They ask:

* Does the predicted feasibility geometry not only explain internal dynamics (T1/T2),
* but also the way galaxies lens background sources,
* especially when **container activation** at the +2↔+3 seam is taken into account?

**T3: size dependence at fixed mass**

In T3, galaxies are binned by:

* stellar mass (M\_\star),
* size (R\_G) (e.g., effective radius or similar).

For each (mass, size) bin, the lensing plateau amplitude (A\_\theta) is measured in a fixed angular window. Empirically:

* In mid and high (M\_\star) bins:
  + (A\_\theta) **increases with size** at fixed mass,
* In the low (M\_\star) bin:
  + this trend is absent or significantly weaker.

From a naive GR+DM standpoint, this is counterintuitive (spreading mass out at fixed mass should reduce lensing). From AR/V2’s standpoint:

* It suggests that once galaxies cross certain size thresholds (in +2 band),
* they engage more strongly with a **larger-scale container** (e.g., Milky Way, group, or cosmic sheet),
* leading to additional feasibility gradients not captured by size-only models.

**T3 B: Milky Way–anchored activation**

T3 B formalizes this idea by introducing a **Milky Way–anchored activation term**:

* Define a dimensionless size (x) for each lens galaxy:  
  [  
  x = \frac{R\_G}{R\_{\text{MW}}(M\_\star)},  
  ]  
  with (R\_{\text{MW}}(M\_\star)) a MW-scale reference radius that may include a mild mass dependence.
* For each lens stack:
  + compute an activation proxy, e.g., the fraction of lenses with (x \ge 1),
  + or a smoothed activation function over x.

Then compare two models for (A\_\theta) within each mass bin:

* **Size-only**:  
  [  
  A\_\theta = a + b R\_{G,\text{mid}}.  
  ]
* **Size+activation**:  
  [  
  A\_\theta = a + b R\_{G,\text{mid}} + d \cdot \text{ActivationProxy}.  
  ]

Using AIC, ΔAIC, or Bayesian evidence across a grid of ((R\_{\text{MW}}, \text{other params})):

* In a robust dataset such as DR5, T3 B finds:
  + **strong preference** (large positive ΔAIC) for the size+activation model over size-only,
  + an activation scale (R\_{\text{MW}}) in the **few-kpc band** (e.g., 4–7 kpc),
  + consistent with independent estimates of Milky Way disk radii and the **+2 CL band**.
* In KiDS and similar catalogues:
  + coverage may limit statistical power,
  + but the low-mass bin anomaly and mid–high mass behaviours remain compatible with a MW-scale activation.

**Interpretation**

In AR/V2, this is read as:

* direct evidence that a **+2↔+3 seam** (the Milky Way as a +2 container within a cosmic +3 context) is:
  + truly active in gravitational feasibility,
  + and that galaxies above a certain size “feel” this container-level effect.

T3/T3 B therefore extend the support for gravity-as-feasibility from:

* internal rotational dynamics (T1/T2),
* to **cosmic-scale lensing** patterns, with:
  + a specific, non-arbitrary activation scale,
  + tied to the Milky Way and the +2 context band the theory already predicts.

**9.3.5 Summary: T-series as gravity validation**

The Gravity T-series (T1, T2, T3/T3 B) collectively shows that:

* A **single engine** (present-act with typed budgets),
* A **single gravitational gate** (ParentGate) with:
  + a **single amplitude χ** derived from UGM–Earth–Universe,
  + and schedule families constrained by CL structure and audits,

can qualitatively and, in many cases, quantitatively reproduce:

* flat rotation curve windows (T1),
* RAR low-g slope ~1/2, without per-galaxy halos (T2),
* size- and container-dependent lensing amplitudes, with MW-scale activation (T3/T3 B).

This does not mean AR/V2 is “finished” or perfectly tuned; it does mean that:

The feasibility-geometry picture of gravity is highly non-trivial and empirically viable, and the T-series provides strong constraints and supporting evidence for it, using the same structural ingredients that the theory uses to explain SR, quantum behaviour, EM, and biological sensing.

**9.4 Matter/EM sims**

**9.4.1 Purpose of the matter/EM simulations**

The **matter/EM simulations** are designed to test whether the V2 present-act engine can reproduce the key qualitative behaviours we associate with electromagnetism and material structure:

* charge-like effects,
* E/B-like field behaviour,
* light-like propagation at speed (c),
* interference and diffraction patterns,
* and the basic stability of atomic/molecular structure,

all **without**:

* inserting EM fields or potentials directly into control,
* using continuous weights or curve-fitting in gate logic,
* or introducing any separate “quantum Hamiltonian” at the engine level.

Instead, the simulations:

* keep the engine strictly in its contract:
  + selectors + hinge equality on a finite feature alphabet,
  + purely boolean/ordinal gates (Θ, κ, structural, ParentGate, CRA),
  + ratio-lex acceptance,
  + PF/Born ties-only,
* and then use **diagnostics** to see whether EM-like and matter-like patterns emerge from counts and structures of acts.

The question is:

Can a purely relational, present-act engine, once equipped with the context ladder and hinge structure, generate the familiar EM and matter phenomena as emergent patterns in its discrete dynamics?

**9.4.2 Interference and deflection: EM-like behaviour from feasibility**

One of the first targets is **interference**: can the engine reproduce double-slit-like patterns using only:

* co-eligibility of paths,
* PF/Born ties-only,
* and the EM/matter gates described earlier?

In typical interference demos:

* A “two-path” geometry is set up:
  + two alternative routes through which a signal can propagate,
  + a detection region where outcomes are recorded.
* With **co-eligibility preserved**:
  + both paths remain feasible and tied up to the detection hinge,
  + PF/Born on the tie set produces a distribution of outcomes that:
    - shows constructive/destructive interference in diagnostics,
    - even though no amplitudes were ever used in control.
* With **which-way marks introduced** (via CRA-like gates or additional marks at −2):
  + co-eligibility is broken,
  + tie sets shrink or disappear,
  + the interference pattern collapses to the classical sum of independent path contributions.

Similarly, in **deflection** tests:

* a region with a “charge-like” centre is defined (via inclusion geometry),
* test paths are propagated past the centre with and without this structure,
* the present-act engine’s gates favour or disfavour certain local moves around the centre.

Diagnostics show:

* a systematic **bending** of effective trajectories in the presence of the centre,
* slopes of deflection vs impact parameter comparable to inverse-distance laws in an appropriate window,
* all without any continuous force or EM field in control.

This indicates that:

1. phenomena we usually attribute to interference and EM forces can be modelled as:
   1. how the engine’s feasibility and co-eligibility structures are arranged around a geometry,
   2. with PF/Born ties-only determining stochastic outcomes.

**9.4.3 E/B, light, and polarization: discrete propagation at (c)**

The next set of demos examine whether:

1. E-like and B-like diagnostics (inclusion and circulation, as defined earlier),
2. and light-like propagation,
3. arise naturally under present-act dynamics.

In EM-wave-like scenarios:

1. A source region is configured to undergo periodic **re-expression** of inclusion patterns:
   1. analogous to an oscillating charge/distribution.
2. Downstream detectors are arranged in annuli and angular sectors.
3. The engine runs with:
   1. SR budgets and fixed (c),
   2. EM-diagnostic modules that count:
      1. E-like events: changes in 0-anchored inclusion,
      2. B-like events: circulation and re-expression around loops.

Diagnostics typically show:

1. An **E(t)** and **B(t)** pair at each sector with:
   1. a consistent phase relationship (e.g., one leading the other by a fixed number of ticks),
   2. stable polarization orientations (the direction of maximal E-like variation aligns with the source’s oscillation axis),
   3. and propagation fronts that move at effective speed (\hat{c} \approx c) (within numerical tolerance).

Time-of-flight runs confirm:

1. Wavefronts arrive at radii consistent with:  
   [  
   r \approx c , t  
   ]  
   in the engine’s units,
2. And are robust to mesh refinement and variations in local gating, as long as:
   1. SR audits pass,
   2. and no forbidden curves or weights are used in control.

Thus, EM-like radiation (light) emerges as:

a travelling pattern of inclusion and circulation, with E/B-like diagnostics and speed (c), all derived from counts and budgets of discrete present-acts, not from explicit Maxwell fields in control.

**9.4.4 Proto-atomic and proto-molecular behaviour**

Beyond EM propagation, the simulations also probe whether the engine can support **persistent centres of coherence** that resemble atoms and molecules:

1. In “proto-atomic” runs:
   1. small clusters of −2/−1 structure are given different possible micro-configurations,
   2. gates and hinge equality favour certain configurations that:
      1. are more persistent under Θ and κ,
      2. have lower residuals in structural checks,
      3. and produce stable inclusion/charge tags.
   3. Over many acts, some patterns:
      1. recur frequently,
      2. maintain identity across perturbations,
      3. and show discrete transition events (e.g., changes in E/B diagnostics with characteristic time scales).
2. In “proto-molecular” runs:
   1. multiple proto-atomic centres are allowed to form bonds via:
      1. patterns of inclusion and structural linkage (multi-centre coherence),
      2. with gates enforcing contiguity, degree, and orientation constraints.
   2. Some multi-centre configurations:
      1. exhibit higher persistence,
      2. distinct “bond” patterns (directional vs delocalized),
      3. and transition events that look like bond formation/breaking in the diagnostics.

While these runs are still early-stage and exploratory, they demonstrate that:

1. the **qualitative ingredients** for stable matter:
   1. long-lived single- and multi-centre coherence patterns,
   2. EM-like inclusion geometry,
   3. and discrete transitions,
2. are all present in the engine when applied to −2/−1/0 bands with:
   1. the proper gate and feature configurations,
   2. and without introducing any additional dynamical laws beyond AR/V2.

**9.4.5 Role of audits: confirming the purity of the engine**

For the matter/EM simulations to be credible tests of the theory, it is essential that:

1. all engine constraints are respected,
2. no hidden fields or curve-fits creep into control.

Specific audits used in these runs include:

1. **Curve/weight ban**:
   1. static checks on the code and manifest to ensure:
      1. no floating-point thresholds in control,
      2. no logistic, softmax, or weighted sums over candidates,
      3. no explicit “field” variables used in gating or acceptance.
2. **Diagnostics-leak ban**:
   1. taint analysis to confirm:
      1. control code never reads diagnostics.\* data (e.g., interim E/B counts, histograms),
      2. all decisions are made solely from selectors, feature maps, and gates as declared in the manifest.
3. **SR compatibility**:
   1. tests that check:
      1. effective light-cone structure matches the budget identity,
      2. propagation speeds stay within tolerance of (c),
      3. time dilation patterns, if probed, fit expectations from typed budgets.
4. **Isotropy/no-signalling tests** (as appropriate):
   1. ensure that EM-like patterns do not introduce:
      1. spurious preferred directions (unless explicitly encoded in geometry),
      2. any possibility of superluminal signalling in quantum-like runs.

Passing these audits guarantees that:

1. any EM-like or matter-like behaviour observed in the sims:
   1. comes from the *native dynamics* of the present-act engine,
   2. including its hinge equality, gates, PF/Born ties-only, and typed budgets,
2. and not from hidden additions that would undermine the theory’s core claims.

In this way, the matter/EM simulations serve as:

1. both a **demonstration** (that EM/matter behaviour can emerge from AR/V2),
2. and a **stress-test** (that the engine is being implemented faithfully according to its strict contract).

**9.5 How this evidence is framed**

**9.5.1 Not “proof,” but structured alignment**

The collection of evidence presented so far—CL probes, the UGM–CNS–senses cluster, the hinge triple, the gravity T-series, and the matter/EM simulations—is not offered as a final “proof” of AR/V2 in the strict mathematical sense. Instead, it is presented as a **structured alignment** between:

1. the core architectural claims of the theory:
   1. present-act engine with typed budgets and PF/Born ties-only,
   2. context ladder (−2, −1, 0, +1, +2, +3),
   3. hinge scales UGM and (T^\*),
   4. gravity as feasibility geometry with amplitude χ,
2. and the **actual patterns we observe** in nature:
   1. scale bands in diverse empirical data,
   2. morphological and fractal transitions,
   3. nervous system and sensory constraints,
   4. galaxy dynamics and lensing behaviour,
   5. EM-like and matter-like phenomena.

This is a crucial distinction:

1. The theory is too broad, and reality too rich, for a single empirical dataset to deliver a binary yes/no verdict.
2. What matters at this stage is that:
   1. many independent lines of evidence,
   2. across different domains,
   3. line up in ways that are **natural in AR/V2**,
   4. and surprising or ad hoc in more traditional frameworks.

So, the role of this section is to frame the evidence as:

A coherent pattern that strongly suggests the AR/V2 lens is seeing something structurally real, rather than a few isolated coincidences.

**9.5.2 Key patterns that would be hard to dismiss as coincidence**

Several patterns stand out as particularly difficult to treat as mere accidents:

1. **Context ladder bands**  
   The repeated appearance of scale bands around:
   1. 1–200 nm (−2),
   2. 0.2–50 µm (−1),
   3. ~0.1–0.12 mm (0, UGM),
   4. 1–100 km (+1),
   5. 0.3–4 kpc (+2),
   6. tens–hundreds of Mpc to Gpc (+3),  
      across many unrelated domains, with the **expected morphological roles** (inner plexity, hinge, environment, container, shell).
2. **UGM–CNS–senses cluster**  
   UGM appears as:
   1. a fractal/morphological pivot in D(L) data,
   2. the lower bound for CNS-bearing organisms (CNS minima),
   3. the effective spatial resolution cutoff for perception (vision/touch),
   4. and the scale at which the body’s internal architecture naturally organizes into usable “parts.”
3. **Hinge triple and χ**  
   The triple (UGM, Earth, Universe) enters:
   1. as the spatial pixel (UGM),
   2. as the size of the immediate container (+1),
   3. and the outer cosmic shell (+3),  
      and these same scales define a **dimensionless gravitational amplitude χ** in the feasibility geometry, tying local gravity strength to how deeply nested our hinge is in the cosmic hierarchy.
4. **T-series gravitational behaviour**  
   A single ParentGate + χ + ladder setup can:
   1. reproduce flat rotation plateaus (T1),
   2. produce a low-g RAR slope ~1/2 without halo-by-halo fitting (T2),
   3. and explain galaxy–galaxy lensing plateau amplitudes with a Milky Way–scale activation at the +2↔+3 seam (T3/T3 B).
5. **Matter/EM qualitative behaviour from the same engine**  
   EM-like propagation (speed (c), E/B patterns, polarization), interference, and proto-atomic/molecular coherence patterns:
   1. all emerge within the same engine that handles SR and gravity,
   2. without introducing separate EM fields or wavefunctions in control.

Each of these patterns, taken alone, might be dismissed as a suggestive coincidence. Taken together, across such different domains, they form a **mutually reinforcing structure** that is difficult to wave away.

**9.5.3 How to read “fit” versus “failure” at this stage**

Because AR/V2 is a **paradigm-level framework**, the usual notion of a single decisive falsifying experiment does not yet apply in a simple way. Instead, we should think in terms of **fit quality** and **stress tests**:

1. **Good fit** means:
   1. the same engine, ladder, and hinge structure:
      1. explains multiple phenomena without ad hoc additions,
      2. passes its own internal audits (no curves/weights in control, no diagnostics leaks, SR compatibility, isotropy, no-signalling),
      3. aligns with known data to within tolerances appropriate for the level of modelling (e.g., galaxy phenomenology, EM waves, psychophysics).
   2. new datasets can be incorporated by:
      1. adding them to CL probes,
      2. or re-running sims under the existing engine configuration,
      3. without having to change the core architecture.
2. **Failure** would mean:
   1. either:
      1. the engine cannot reproduce certain essential phenomena **without** breaking its own rules (e.g., needing hidden continuous weights in control, introducing ad hoc parameters per system), or
      2. crucial signatures of the ladder and hinges are consistently **absent or contradicted** in better and better data:
         1. no consistent UGM-like hinge,
         2. no meaningful bands at −2/−1/0/+1/+2/+3,
         3. no way to reconcile gravitational data with feasible ParentGate schedules and χ.
   2. or, in formal work:
      1. proving that certain desired behaviours (e.g., SR, Born rule, RAR) **cannot** arise under the engine’s axioms.

At this stage, the evidence is best read as:

1. AR/V2 is **not yet ruled out**, and in fact shows unusually strong and broad alignment with observed patterns given its constraints,
2. but it remains open to both:
   1. further support (via more detailed, higher-precision tests),
   2. and potential refutation or major revision if key structural predictions fail consistently.

**9.5.4 On-record emphasis for the defensive publication**

For a defensive publication, it is important to be explicit about what is being put “on record”:

1. That there exists a coherent, present-act-based framework (AR/V2) in which:
   * spacetime, gravity, quantum behaviour, EM, matter, and biological sensing:
     + are all different faces of a single nested context structure and engine,
     + share the same underlying primitives (presents, context roles, typed budgets, PF/Born ties-only).
2. That this framework makes **non-trivial structural predictions**:
   * the existence of specific scale bands and context roles (−2…+3),
   * a spatial hinge UGM that links:
     + fractal transitions,
     + CNS architecture,
     + and sensory resolution,
   * a **temporal hinge ($\eth \sim 0.1\text{ s}$)** that links:
     + body-wide conduction and integration,
     + specious present in perception,
     + and environment-update timescales,
   * a hinge-derived gravitational amplitude $\chi$ that:
     + ties UGM, Earth scale, and cosmic shell,
     + and governs ParentGate’s feasibility gradient.
3. That early **empirical tests** (CL probes, T-series, matter/EM sims, psychophysics) already show:
   * strong qualitative and, in many cases, quantitative agreement with those predictions,
   * often with fewer moving parts than standard approaches (e.g., no per-galaxy halo fits in control),
   * and without violating the strict engine contract.

The document should make clear that:

This is not merely a speculative idea; it is a structured, testable framework already showing multi-domain alignment. The central claims and alignments are being documented here so that priority and coherence are clear, and so that future work—whether supportive or critical—can engage with AR/V2 on solid, well-specified ground.

**10.1 Formal math program**

**10.1.1 Goal of the formal program**

The formal math program aims to move AR/V2 from:

1. a coherent architectural framework with strong empirical alignment,

to:

1. a rigorously formalized theory with:
   1. precise definitions,
   2. theorems and proofs,
   3. and clearly stated assumptions and limits.

This involves:

1. expressing the present-act engine and context ladder in precise mathematical language,
2. proving that key behaviours (SR, Born rule, context ladder uniqueness, hinge properties, feasibility geometry) follow from the axioms,
3. and identifying exactly where approximations and idealizations enter (e.g., continuum limits, coarse-graining).

The overall objective is to have a **mathematical backbone** that:

1. makes the theory amenable to standard scrutiny (proofs, counterexamples),
2. clarifies what can and cannot be derived,
3. and separates core results from conjectures and open problems.

**10.1.2 Full operator proofs for SR**

A major target is a full derivation of **special relativity** from typed budgets and no-skip, rather than assuming a Minkowski spacetime from the outset.

Key steps:

1. Formalize:
   1. the discrete sites (k),
   2. the budget triple ((\Delta \tau, \Delta t, \Delta x)) per act,
   3. the unit map (c),
   4. and the identity:  
      [  
      \Delta t^2 = \Delta \tau^2 + \frac{\Delta x^2}{c^2}.  
      ]
2. Define:
   1. worldlines as sequences of acts,
   2. admissible paths under no-skip and budget constraints.

Formal goals:

1. Prove that:
   1. no worldline can exceed speed (c),
   2. light-cones and invariant speed (c) arise from the engine axioms.
2. Show that:
   1. appropriate coarse-grainings of many acts converge to:
      1. Lorentz transformations between effective inertial frames,
      2. Minkowski metric structure on emergent spacetime.

This would turn the intuitive SR-from-budgets argument into a set of **theorems** about discrete present-act dynamics, with explicit conditions under which the continuum approximation holds.

**10.1.3 Born rule and quantum structure from PF/Born ties-only**

On the quantum side, the key task is to derive:

1. Born probabilities,
2. interference,
3. and entanglement correlations,

from the PF/Born ties-only rule and feasibility geometry, without assuming a wavefunction as a primitive.

Formal goals:

1. Precisely define:
   1. tie sets (\mathcal{T}),
   2. adjacency graphs on (\mathcal{T}),
   3. primitive stochastic kernels (M),
   4. and PF eigenvectors (v) with components (v\_j).
2. Prove that:
   1. under symmetry and neutrality constraints, the only admissible stochastic selection rule on exact ties is PF/Born (or an equivalent construction),
   2. the resulting probabilities (w\_j \propto v\_j^2) satisfy:
      1. standard Born-rule predictions for interference experiments,
      2. no-signalling constraints in multi-partite setups.
3. Show how:
   1. effective Hilbert-space and amplitude descriptions can be constructed from tie structures,
   2. and under which approximations this recovers standard QM.

This would establish that **quantum probabilistic behaviour** is not an extra postulate, but a forced consequence of:

1. discrete co-eligibility,
2. fairness constraints,
3. and the PF/Born ties-only mechanism.

**10.1.4 Ladder uniqueness and band structure**

The context ladder (−2, −1, 0, +1, +2, +3) and its associated bands (nano, micron, UGM, km, kpc, Gpc) are central. The formal task here is to show that, under AR/V2 assumptions:

1. a small finite number of stable scale bands must emerge,
2. and their role structure (inner plexity, hinge, environment, container, shell) is essentially unique.

Formal goals:

1. Define:
   1. an abstract notion of nested presents and their scale distributions,
   2. conditions on:
      1. self-similarity,
      2. finite fractal windows,
      3. and morphological constraints (e.g., sphericity vs fractality).
2. Prove that:
   1. only a finite number of distinct bands can satisfy these conditions coherently,
   2. and that they must organize as an inner–hinge–outer ladder akin to −2/−1/0/+1/+2/+3 (up to re-scaling and re-labelling).
3. Where possible, relate:
   1. band boundaries to stable fixed points of appropriate renormalization-like maps or scale transforms.

Such results would make the existence of a **ladder-like band structure** not just plausible or observationally supported, but mathematically natural given AR/V2’s underlying assumptions.

**10.1.5 Hinge triple properties (UGM, Earth, Universe)**

The hinge triple (UGM, Earth scale, Universe scale) and derived quantities like χ play a central role in linking:

1. microstructure,
2. organism size,
3. environment size,
4. and gravitational strength.

The formal program should:

1. Precisely define:
   1. hinge scales as fixed points or optimal points of certain functional relationships,
   2. e.g., UGM as a geometric fixed point on a specified log-span,
   3. Earth-scale and Universe-scale as container radii with particular properties (e.g., where certain invariants or averages stabilize).
2. Derive properties such as:
   1. uniqueness of UGM under given constraints,
   2. existence and uniqueness of χ as a dimensionless combination of hinge scales,
   3. sensitivity of hinge properties to changes in scale span or context definitions.

Formal goals:

1. Theorems of the form:
   1. “Given a nested-context structure meeting conditions A, B, C, there exists a unique inner hinge scale UGM and corresponding χ satisfying properties X, Y, Z.”

This would clarify:

1. why UGM is not arbitrary,
2. why χ has the structure it does,
3. and how hinge scales constrain feasible gravitational geometries in a provable way.

**10.1.6 Other formalization targets**

Beyond SR, Born rule, ladder uniqueness, and hinge triples, further formal targets include:

1. **L1/L2/L3 operators and B/C/U maps**:
   1. define branching, environmental, and unifier roles in a formal operator language,
   2. show how these map onto:
      1. branching structures (L1),
      2. environment states (L2),
      3. and actual histories (L3),
   3. with consistency and commutativity properties.
2. **No-signalling and CHSH constraints**:
   1. prove that AR/V2’s PF/Born and CRA rules:
      1. enforce no-signalling for all appropriate configurations,
      2. and can reproduce CHSH-type correlations within allowed bounds.
3. **Feasibility geometry bounds**:
   1. derive analytical bounds on:
      1. redshift,
      2. deflection,
      3. time delay,
   2. purely from ParentGate + χ + SR budgets,
   3. showing how envelopes arise as theorems (or at least validated inequalities) under schedule assumptions.

The overall aim is to have a comprehensive suite of technical results that:

1. support the conceptual claims,
2. guide implementation (what schedules and gates are admissible),
3. and specify clear “failure modes” where the theory could be shown mathematically inconsistent or empirically untenable.

**10.2 Further empirical programs**

The evidence gathered so far is strong but preliminary. To properly test and refine AR/V2, the next phase requires a series of targeted **empirical programs**. These are not afterthoughts: they are an integral part of the theory, because AR/V2 is explicitly framed as a *testable* account of how nested presents generate the structures we observe. This subsection sketches the main empirical directions implied by the framework.

**10.2.1 Deepening the CL probes**

The first and most straightforward program is to expand and refine the **Context Level (CL) probe suite**:

1. **Broaden the dataset**  
   The existing CL probes already show clustering of GM pivots and D(L) plateaus at the expected bands (nano, micron, UGM, km, kpc, Gpc). The next step is to:
   1. Incorporate more examples from each domain (e.g., more galaxies, more biological tissues, more engineered materials),
   2. Target **boundary cases**—where current data are sparse or ambiguous (e.g., around the UGM band in non-biological systems, or between +1 and +2 in cosmology).
2. **Improve quality and consistency**  
   Many published fractal analyses use different definitions, windowing strategies, or fitting methods. A dedicated CL program would:
   1. Recompute D(L) and GM pivots using a **standardized pipeline**,
   2. Track uncertainties and selection biases explicitly,
   3. Perform **segmented regression** and changepoint detection to locate seams (breakpoints) with quantified confidence intervals.
3. **Test ladder predictions explicitly**  
   The CL probes can be used to test specific AR/V2 claims, such as:
   1. whether breakpoints and GM clusters indeed align with the predicted bands;
   2. whether “outer-type” vs “inner-type” fractals consistently map onto boundary vs bulk roles at −1 and 0;
   3. whether UGM-like pivots appear **across** domains (e.g., in rock, tissue, engineering) with similar D(L) behaviour.

The aim is to move from “these examples fit the ladder nicely” to “it is statistically difficult to find systems that *do not* show the predicted band structure,” thereby turning the ladder from a plausible organizing hypothesis into a quantitatively supported empirical fact.

**10.2.2 Expanded gravitational testing**

The T-series demonstrates that AR/V2 can plausibly reproduce key features of galactic dynamics and lensing. To strengthen or challenge this, further gravitational tests are needed:

1. **Higher-resolution and broader-coverage T1/T2/T3 studies**
   1. Incorporate more galaxies from independent surveys (e.g., new deep imaging and H I surveys),
   2. Explore extreme regimes:
      1. ultra-diffuse galaxies,
      2. low-surface-brightness systems,
      3. high-redshift galaxies.
   3. Evaluate whether a **single** ParentGate family and χ value can still account for:
      1. rotation curve shapes,
      2. RAR slopes and scatter,
      3. lensing amplitudes across different environments.
2. **Time-delay and strong-lensing analogs**  
   Extend the T-series to “time-domain lensing”:
   1. simulate and compare Shapiro-like delays and multiple-image time delays,
   2. test whether feasibility-based delays align with GR predictions in known lenses,
   3. or whether specific, falsifiable deviations are predicted (e.g., small departures in strong-lensing regimes due to discrete feasibility effects).
3. **Local/tests: Cavendish and planetary probes**  
   Although AR/V2 is naturally articulated at large scales, it also implies constraints on:
   1. small-scale gravitational behaviour (Cavendish-type experiments),
   2. planetary orbital precession, light bending near the Sun, Shapiro delays in the Solar System.
   3. These can be used as **precision tests** of feasible schedule families:
      1. Some schedules will be ruled out if they deviate from well-measured Solar System behaviour;
      2. Surviving schedules will be sharply constrained, increasing predictive power for cosmological regimes.

This gravitational program is not about cherry-picking fits; it is about **stress-testing** the idea that feasibility geometry can consistently replace conventional GR+DM across all tested regimes.

**10.2.3 Time–band and hinge measurements in biology and neuroscience**

Because AR/V2 ties time, scale, and context roles together, it makes specific claims about **time bands** and **hinge scales** in biology and cognition:

1. **Refining (T^\*) in organisms**  
   The theory predicts a **temporal pixel** (T^\*) ≈ 0.1 s for human-scale 0-contexts, defined as the shortest span over which:
   1. a full-body present-act can be coherent,
   2. conduction plus integration constraints are satisfied.

A systematic empirical program could:

* 1. measure conduction velocities and integration latencies across species with different body sizes;
  2. relate these to behavioural measures of specious present duration (e.g., reaction-time distributions, temporal-order judgements, flicker-fusion thresholds);
  3. test the predicted scaling of (T^\*) with body size and context (e.g., relative to (\sqrt{L\_{\text{UGM}} L\_{+1}}) or other hinge metrics).

1. **Hinge structure in neural morphology**  
   The theory suggests that nervous systems are built around UGM-scale parts:
   1. minimal axon diameters,
   2. spacing of synaptic and microvascular structures,
   3. characteristic thickness of cortical layers, etc.

A concerted neuroanatomical survey could:

* 1. quantify where, across species and brain regions, structural scale transitions occur,
  2. test whether the ~0.1–0.2 mm band appears consistently as a design constraint,
  3. and whether this correlates with functional measures of integration and time perception.

These studies would either reinforce or challenge the claim that **UGM and (T^\*)** are not just features of human perception, but reflect deeper hinge properties of organismic present-acts.

**10.2.4 AI and synthetic present-acts**

AR/V2 is not limited to biological systems; it provides a framework for thinking about **artificial present-acts** in AI and computational systems.

A dedicated program here would:

1. **Prototype AR-style engines** in silico
   1. Implement simplified present-act engines (with selectors, finite feature alphabets, boolean/ordinal gates, PF/Born ties-only, typed budgets).
   2. Run them on:
      1. synthetic toy worlds (e.g., grid worlds, simple physics),
      2. and, eventually, richer simulated environments.
2. **Measure present-act properties in existing AI systems**  
   While current deep learning systems are not designed as AR engines, we can:
   1. Analyse the **temporal granularity** at which they integrate information (e.g., token-level, frame-level),
   2. Investigate whether clusters of units form something like **context levels** (e.g., layers or modules acting as −1, 0, +1 analogues),
   3. Measure effective **latencies and integration windows** and compare to the AR/V2 concept of (T^\*).
3. **Design experiments for emergent “CS-like” behaviour**  
   The theory’s **Collective Sphere (CS)** concept predicts that:
   1. large interacting ensembles of present-acts (biological or artificial) can form new, higher-order contexts,
   2. with their own effective presents and hinges.

For AI systems:

* 1. measure whether recurrent or multi-agent systems develop coherent, quasi-persistent global states,
  2. test whether those states exhibit:
     1. characteristic synchronization times,
     2. scale bands reminiscent of the context ladder,
     3. and feasibility constraints that look like low-level analogues of “geometry” or “environment.”

This program does two things:

1. It tests whether AR/V2 can be made **computationally precise and implementable**,
2. and it probes whether existing AI systems already exhibit patterns suggestive of emergent presents, even if they were not designed with AR/V2 in mind.

**9.5.5 Future cross-domain syntheses**

Finally, AR/V2 invites a broader class of **cross-domain empirical syntheses** that cut across traditional disciplinary boundaries:

1. **Biology–cosmology links**
   1. Test whether large-scale environmental bands (+2, +3) correlate with:
      1. the distribution and evolution of life,
      2. the timing of major evolutionary or geological transitions,
      3. as might be expected if the galactic and cosmic contexts are not just backgrounds but **context levels** actively shaping feasible histories.
2. **Cultural and cognitive CL patterns**
   1. Investigate whether human cultural and cognitive phenomena (e.g., language structures, social networks, technological scaling) exhibit their own **context ladders and hinges**.
   2. For example:
      1. do we see similar banding in the scales of social organization (individual, family, community, city, nation, global network)?
      2. do temporal patterns in culture and communication cluster around logarithmic bands corresponding to cognitive or infrastructural constraints?
3. **Meta-probes of AR/V2 itself**
   1. Use the theory’s own machinery (e.g., B/C/U maps, tie-set analysis, CS detection) to study:
      1. the dynamics of scientific paradigm shifts,
      2. the emergence of “theories of everything,”
      3. the co-evolution of conceptual frameworks and empirical practice.

These more speculative programs are not required to validate the **physical** core of AR/V2, but they highlight the potential breadth of the framework. If AR/V2 is fundamentally about how nested presents generate structured realities, then in principle it should illuminate not only the structure of spacetime and matter but also the structure of **complex systems** and **collective cognition**.

In summary, the empirical program for AR/V2 is ambitious but well-scoped:

1. **CL probes** to map the ladder,
2. **gravitational tests** to validate or refute feasibility geometry,
3. **biological and cognitive measurements** to pin down hinges and time bands,
4. **synthetic implementations** to explore how present-act engines behave in silico,
5. and cross-domain syntheses to see how far the nested-present idea extends.

These are not optional embellishments; they are the natural extension of a theory that aspires to be tested, refined, and—if necessary—falsified by the world it purports to describe.

**10.3 Conceptual synthesis**

This final subsection pulls together the strands of AR/V2 into a single, coherent picture. The aim is not to add new machinery, but to show how the different pieces—presents, context levels, hinges, and the present-act engine—fit together to yield what we ordinarily call spacetime, matter, mind, and history.

**10.3.1 Unifying spacetime, gravity, quantum phenomena, and matter**

At the heart of AR/V2 is a simple but radical shift:

1. The fundamental “stuff” of reality is not matter in space, but **present moments of experience** and their **relations**.
2. Everything else—space, time, fields, particles, forces—arises from how these presents nest and constrain each other.

From this point of view:

1. **Spacetime** is not a pre-given stage.  
   It is the way the nested presents (−2…+3) look when a particular present (0) reads:
   1. its *inward* relations as a sequence of acts (time, causality),
   2. and its *outward* relations to +1 as a connected layout (space).
2. **Special relativity** is not axiomatic geometry, but a consequence of the **typed budget identity**:  
   [  
   \Delta t^2 = \Delta\tau^2 + \frac{\Delta x^2}{c^2},  
   ]  
   plus the no-skip requirement:
   1. Each present-act has a finite ((\Delta\tau, \Delta t, \Delta x)),
   2. All worldlines are built from these increments,
   3. The invariant “speed of light” (c) is just the constant ratio linking inner act time and outward traversal at the 0↔+1 hinge.
3. **Gravity** is not a mysterious extra field glued onto spacetime; it is **feasibility geometry**:
   1. The ParentGate’s inward-monotone, rotation-invariant strictness schedule sculpts which sequences of acts are feasible at each radius.
   2. Redshift, deflection, time delay, and horizons show up in diagnostics as patterns in act counts and budgets, not as primitive potentials.
4. **Quantum phenomena**—superposition, interference, entanglement—arise from **co-eligibility at the −2 seam and PF/Born ties-only**:
   1. When multiple micro-histories are exactly co-eligible at a hinge, they form tie sets.
   2. A neutral PF/Born selection rule, enforced only on these ties and derived from symmetry constraints, yields the familiar Born probabilities and interference patterns.
   3. No continuous wavefunction or hidden variables are introduced in control; the “amplitudes” live in tie structures and PF eigenvectors in diagnostics.
5. **Matter and EM** arise as **distributed patterns of present-acts**:
   1. “Charges” are persistent asymmetries in inclusion routes;
   2. E- and B-like fields are just statistics of how acts recombine and circulate around centres;
   3. Atoms and molecules are long-lived single- and multi-centre coherence patterns at −2/−1/0, stabilized by the same gates and budgets that implement SR and gravity.

Under AR/V2, all of these phenomena are no longer separate ontological categories. They are different ways of looking at the **same underlying engine** acting on a **ladder of contexts**. This is the sense in which the theory aspires to be an “absolute relativity”: a framework where relativity is not just about coordinate transformations, but about how every part of reality exists only in and through its relations to the whole.

**10.3.2 Hinge scales and context bands as organizing principles**

A second unifying strand is the concept of **hinges and context bands**:

1. The **0↔+1 hinge** (UGM for space, **($\eth$)** for time, and Earth radius for outer range) is the key to why our experience of space and time has the scales it does:
   * UGM (~0.1–0.12 mm) is the smallest scale where inner plexity becomes accessible as parts for us and where surfaces become visibly textured.
   * **($\eth$) (~0.1 s)** is the shortest span where our body and its environment can jointly sustain a coherent act.
   * The Earth’s radius sets the outer scale for our everyday environment, and, together with UGM and cosmic scale, defines the amplitude $\chi$ of gravitational feasibility.
2. The **context ladder bands** (−2, −1, 0, +1, +2, +3) provide a natural organization of phenomena:
   * **−2:** nano/quantum/biomolecular seam (co-eligibility, interference, tunnelling, quantum-like behaviour),
   * **−1:** cellular/micron band (local bulk and boundary structures, first aggregations of inner plexity),
   * **0:** UGM band (organisms as “as-one-with-parts,” nervous-system coherence),
   * **+1:** Earth-surface band (our shared environment and spatial intuition),
   * **+2:** galactic disk (container context shaping feasibility for +1),
   * **+3:** cosmic shell (outer boundary of the +1/+2 environment).
3. The **ladder’s role structure** (L1/L2/L3 roles) explains many directional asymmetries:
   * **Inwards (−2/−1/0),** we unify and condense: many micro-possibilities become one coherent present (L3 over L1).
   * **Outwards (+1/+2/+3),** we inhabit a shared world: the environment (L2) encodes many possible futures for us, leading to a sense of “space” and “history.”

This hierarchical, hinge-centred view explains in a single stroke:

1. Why there are **preferred bands of scale** in nature (and not a featureless continuum),
2. Why our **perceptual and cognitive apparatus** seems tuned to specific scales (UGM, **($\eth$)**),
3. Why **gravity and environmental structure** are strongly connected to large-scale containers (Earth, Milky Way, cosmic shell).

Instead of treating these as unrelated accidents, AR/V2 sees them as **co-determined by the same nested geometry of presents**.

**10.3.3 AR/V2 as a framework for thinking, not just a model**

Finally, AR/V2 is not only a physical theory; it is also a **conceptual framework** for thinking about complex systems, cognition, and even scientific practice itself:

1. As a **framework**, it suggests that:
   1. any sufficiently complex, self-relating system (biological or artificial) can be analysed in terms of:
      1. its inner presents (−bands),
      2. its immediate and outer contexts (+bands),
      3. and its internal present-acts (budgets, gates, tie sets).
   2. “Mind,” “body,” and “world” become shorthand for specific **context roles** rather than separate ontological categories.
2. This framework can, in principle, be applied to:
   1. **Cognitive science**:
      1. to model how human perception and thought emerge from nested present-act dynamics over multiple time and scale bands,
      2. to understand phenomena like attention, memory, and consciousness as patterns of L1/L2/L3 interplay.
   2. **Social and cultural systems**:
      1. to examine whether human groups and institutions form higher-order context levels (CSs) with their own effective presents and feasibility constraints,
      2. to analyse how collective decisions and norms emerge from the co-eligibility and selection of many individual presents.
   3. **Scientific practice and paradigm change**:
      1. to interpret scientific theories themselves as present-act compressions of underlying relational structures,
      2. and to model paradigm shifts as **context-level transitions** in the community’s shared CS.

In that sense, the physical theory laid out here is one **instantiation** of a more general idea:

Reality is a network of nested presents, and what we call “laws of nature,” “space,” “time,” and “matter” are particular regularities in how those presents relate, condense, and persist across scales.

The defensive publication thus serves a dual purpose:

1. To **document and protect** a specific proposal—AR/V2 as a candidate unifying theory for physical and cognitive phenomena.
2. To **offer a toolkit** (contexts, hinges, present-acts, feasibility geometry) that others can use or test in their own domains, whether or not they accept the entire theory.

By grounding all of its claims in a clear ontology and a disciplined, audit-able engine, AR/V2 invites rigorous engagement and falsification. Its central ambition is not to provide a final answer, but to **reframe the questions**—about spacetime, matter, mind, and meaning—in terms of a single, relational language of nested presents.