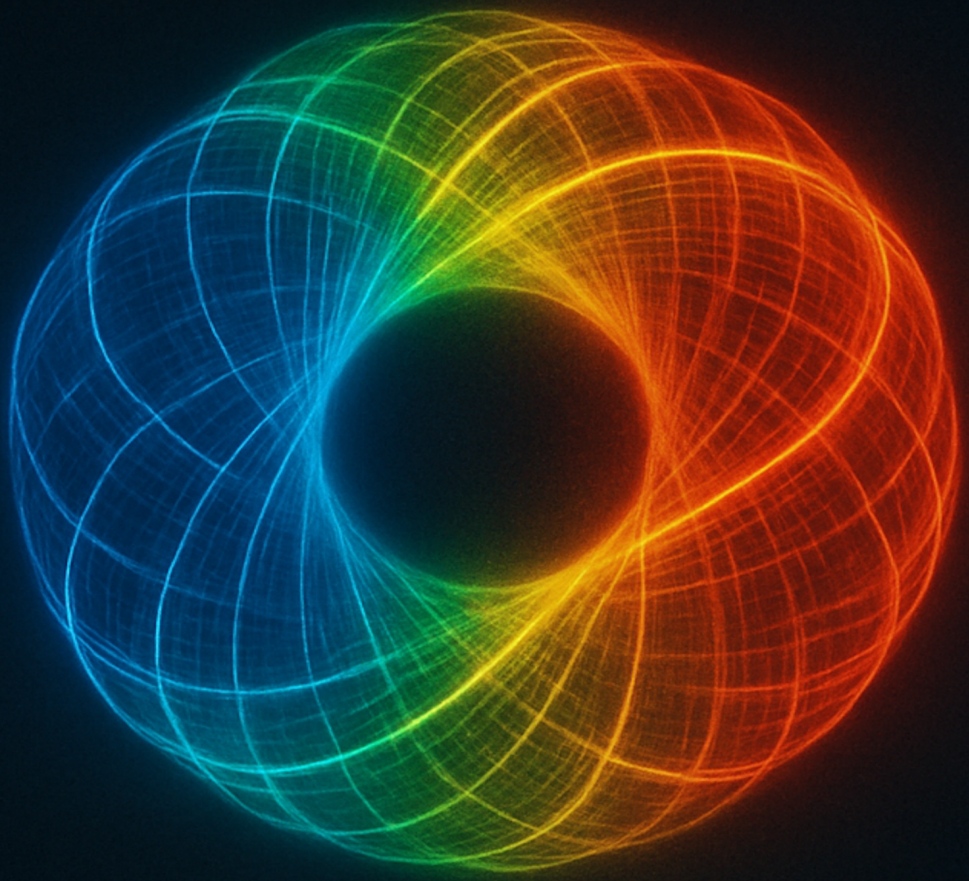
A MAXWELL UNIVERSE



All-there-is from electromagnetic energy.

AN M. RODRIGUEZ

A Maxwell Universe

All-there-is from source-free electromagnetic energy.

Part I

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Acknowledgments

To my friend, that contributed to almost every idea here written; knowingly or unknowingly.

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Part I develops a framework in which events are the starting point. A registered change creates the basic distinction between "before" and "after." Systems that update their state in response to influences build internal orderings, and from these orderings time emerges.

Causal steps link events into chains, and then loops. Loops support recurrent patterns and can act as clocks. Counting causal steps gives duration and also distance: the minimal number of steps between two events. Collecting all pairwise distances produces an effective geometry.

Space and dimension arise when these distances can be embedded with low distortion into a space of some dimension. Multiple embeddings imply non-unique dimension; failure of all embeddings implies that geometry does not apply. Space and dimension are therefore relational constructs, not fundamental ingredients of reality.

The same compression mechanism explains arithmetic and mathematical laws. Stable patterns become symbolic rules; when the patterns shift, the rules shift with them. Mathematics succeeds where reality presents regularities, and fails where it does not.

Across Part I, a single theme recurs: we do not access the underlying causal structure itself. We access only its effects, and from these we construct representations that remain valid only while the observed patterns stay stable.

1. From Darkness, Light

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Reality begins not with space or time, but with the simple fact that events happen.

We often assume events happen for a reason. This doesn't need to be so, and even if it is, we don't have direct access to the causal information, but indirect through its effects.

A reason is a story added later. What matters is simply that a change occurs and that it is registered in a way that affects what follows. Once a change is registered, the system occupies a different state. The distinction between "before" and "after" is not added to the event; it is the event.

There is no need to appeal to an intelligence recording what happened, but only to a persistent state change —like a scratch on a table— that constrains future interactions. The scratch is not a record of the event. The scratch is the event, insofar as it makes a difference.

The sense of reason or explanation arises only as a reactive story, a way of organizing transitions once change has been noticed by a reasoning entity (a topic addressed later in [1]).

This reactivity is not limited to conscious minds. Anything that changes in response to causes and produces effects is, in this minimal sense, **operationally aware** [2].

[1] Rodriguez, A. M. (2025). *Emergence of Self-Awareness from a Cause–Effect Loop.* https://preprints.preferredframe.com/Emergence%20of%20Self-Awareness%20from%20a%20Cause%E2%80%93Effect%20Loop/Emergence%20of%20Self-Awareness%20from%20a%20Cause%E2%80%93Effect%20Loop%20v2.md.html

[2] Palma, A., & Rodriguez, A. M. (2025). *Operational Awareness in a Maxwell-Only Universe: A Formal Implication of Panpsychism.* ResearchGate.

A self-sustaining causal loop qualifies: it can update its own state in response to incoming influences. By doing so, it distinguishes states and tracks transitions—not through any "plan of action," which would imply a consciousness we have not yet defined, but simply by virtue of its continued existence as a loop. In this minimal operational sense, a self-sustaining causal loop "notices" change.

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2. Time

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Time is, thus, a construct: a tool operational awareness uses to organize its state. Each loop forms its own internal notion of time. Yet we maintain collective agreements: certain event-patterns ("causes") tend to precede others ("effects"). Those who do not share the prevailing interpretation are often labeled "irrational," though this only reflects different mappings between change and order.

We may picture "reality" [3] as a Node with an unknowable internal structure [4]. All we know is that this structure reproduces patterns of transitions from which we infer "before" and "after."

What we call "the past" is reconstructed *now*, from present evidence. If new evidence appears, our reconstruction may shift. The long debate about whether dietary fat was harmful or beneficial is a familiar example later shown to rest on selective data [5]. Consensus reality is fragile. Without external anchors, interpretations feel arbitrary, raising the persistent question: what is real?

[3] Reality—"all that is"—includes everything you can think of and everything you suspect exists but do not consciously consider. Any formal definition is partial.

[4] As in Plato's cave: the underlying structure is inaccessible in principle. We see only shadows and name some "causes" and others "effects."

[5] Late-20th-century nutrition science framed fat as the main cause of heart disease, but later reviews showed selective reporting and industry influence. Contradictory data had been minimized. Re-analysis revealed a weaker link than claimed, showing how consensus can form around distorted evidence.

3. Orderings

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From the primitive relation

$$n_i \succ n_j,$$

meaning "n_i causes n_j," an ordering arises: before and after. We may call this succession of events i and j a **causal step**.

A series of events forms a **causal chain**: i → a → b → c → d → j.

Chains can form loops:

... → j → i → a → b → c → j → i → ...

and may cross themselves without restriction. Learning is a good illustration of multiple acknowledgdments and thus multiple "closes". A loop can be considered "closed" when its pattern stabilizes in some useful sense. A "closed" loop, has however to continue propagating, as we mention later.

Repeated causal loops can function as clocks. Any recurrent sequence can serve as a clock. Accuracy varies, but recurrence suffices.

Note that an effect that produces no further causes marks the end of a causal chain. Such an endpoint cannot be registered—there is no return influence. Therefore the fact that anything is noticed at all implies that the noticer is, in essence, a self-sustaining causal loop.

4. Counting Steps

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By counting loops or causal steps, operational awareness defines durations. Time is an emergent count, not an external parameter.

Distance arises by tracking how many causal steps connect two events. If a signal travels from event i to event j through a minimal chain of length L_{ij}, then

$$d(i, j) \propto L_{ij}.$$

If no path exists, the distance is infinite or undefined. If the only available path returns to the same event, the round-trip count becomes an effective measure of separation. Distance is not a spatial coordinate but an operational measure of causal separation.

These causal distances define an effective geometry. Observers attempt to map them into familiar spaces of some chosen dimension.

More technically, we can think of a map $\mathcal{M}$ into a space of dimension D, where each event is assigned a point, and the distances between those points approximate the causal distances:

$$\|\mathcal{M}(i) - \mathcal{M}(j)\| \approx d(i, j).$$

When such embeddings succeed with low distortion, observers perceive the corresponding events as forming a D-dimensional structure under $\mathcal{M}$. If multiple embeddings work, dimension is not unique. If none succeed, all such maps $\mathcal{M}$ are defective and geometry is ill-defined.

Thus, space, time, and dimension are not fundamental; they arise from how operational awareness compresses relational patterns. Geometry and distance appear only after repeated causal patterns stabilize into expectations.

5. Space

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Distance is the count of causal steps between two events. What we call "space" is the collection of all such distances. By gathering every pairwise separation into a single structure, operational awareness attempts to form a coherent geometric representation.

If the full set of causal distances can be embedded with low distortion into some D-dimensional space, we say the events appear to be D-dimensional. If no low-distortion embedding exists, the notion of dimension breaks down.

The same distance data may admit several embeddings. A configuration may fit a triangle, two overlapping triangles, a star, or other shapes. Nothing enforces a unique interpretation; different interpretations may even coexist and function adequately. We only have effects—the causal distances—and from them we infer patterns to some acceptable accuracy. The preferred embedding is usually (but not always) the one that compresses the relations with minimal complexity while keeping distortion tolerable. Occam's razor reflects this preference.

This pattern-recognition mechanism is not limited to geometry. Arithmetic emerges the same way. Repeated causal acts—placing one apple in a bag, then another—stabilize into a reliable pattern. From this, operational awareness forms the abstraction that $1 + 1 = 2$. If two apples reliably produced three, arithmetic would encode that instead, and we would again regard the universe as "mathematical." The rule is not discovered beneath reality; it is extracted from consistent effects and then used to predict further effects.

In some contexts, $1 + 1$ can take any value permitted by the rules. One may define a formal system where $1 + 1 = 3$ and build consistent mathematics from it. Even in everyday settings, combining two things rarely doubles a quantity cleanly. The

outcome depends on the combination rules: posture, leverage, strategy. Only once those rules are fixed does the expression $1 + 1 = 2$ become the correct statement. The "truth" of arithmetic reflects operational assumptions, not the causal substrate.

Space, time, dimension, and arithmetic arise from the same mechanism: recognizing regularities in causally connected events and compressing them into stable, predictive representations.

6. Plato and the Cave

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Plato illustrated the limits of our access to reality. We see shadows, not the real source. Our interpretations are reconstructions shaped by limited observation. There is no external vantage point from which the true structure can be viewed.

We do not have direct access, or in other words, can never observe the underlying causal substrate of reality; we observe only the effects that reach us.

Any geometry, dimension, or pattern we assign reflects how these effects can be compressed into a usable representation. A different observer, or a different sampling of the same causal structure, may construct a different representation without contradiction.

Shadows in Plato's cave correspond to the relational patterns we detect. The "objects" casting those shadows are the underlying causal relations, which are inaccessible in themselves. We infer their organization from recurring effects, and when those effects change, our inferred picture must change with them. No representation we construct is guaranteed to be unique, complete, consistent, or stable.

This perspective removes the assumption that there is a single, correct spatial or mathematical description waiting to be uncovered. Our models are not mirrors of an external geometry; they are operational tools built from the limited regularities we can register. Like the prisoners in the cave, we work with projections, not with the structure that produces them.

What we call "reality" is therefore a reconstruction: a stable arrangement of inferred patterns that remains useful so long as the causal effects available to us support it.

7. Logic, Mathematics, and Reality

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Much has been said about reality being "mathematical," though the phrase is rarely defined. The arguments above suggest a simpler view: we ascribe patterns to reality. Sometimes, we genuinely recognize these patterns, sometimes because we project them and then treat the projection as real.

Mathematics does not need to govern the world. Even if reality admits mathematical structure in some sense, mathematics itself is vastly larger than anything the world could instantiate. Most mathematics has no physical counterpart at all, that we know of, yet.

More often, we see the world through the mathematics we have constructed. Mathematics —and therefore physics— describes those aspects of reality that admit stable, compressible patterns. When a pattern is regular enough to be anticipated, we encode it symbolically and call the result a "law." When the pattern breaks, the law breaks with it.

It is therefore not that reality is mathematical, nor that mathematics is the "language of nature." Rather, mathematics is a modeling tool we apply to the regularities we can isolate and predict. Wherever reality resists compression into stable patterns, mathematics simply does not apply.

Mathematics succeeds because we select what it can describe —and which patterns we attend to— not because nature is made of numbers, structures, or -the lastest rebranding- "information."

The same is true of logic. Logic is not a law imposed on reality; it is an abstraction distilled from stable, repeatable causal behavior. Classical logic reflects a world in which states are well-separated and transitions are consistent.

Just as spatial geometry emerges from the compression of causal distances into low-distortion embeddings (§4–§5), logical structure emerges from the compression of causal transitions into stable inference rules.

When causal structures change, the logic extracted from them changes as well. That modern physics tolerates superposition or incompatible descriptions does not mean that reality violates logic. It means that classical logical categories no longer compress the observed causal patterns.

This work therefore starts neither from logic nor from mathematics, but from cause and effect. Logic and mathematics enter later, as tools shaped by the regularities that causal interactions happen to exhibit.

Appendix — Assumptions and Derived Commitments

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This work adopts a minimal ontology. Only the first three assumptions are primitive. All others follow from them.

A.1 Fundamental Assumptions

A1. Events occur. There are changes.

A2. Change can be registered. Some changes persist as state differences.

A3. Registered change is itself the effect that follows. A registered change is a new state, and nothing beyond this is required.

No space, time, matter, laws, logic, or mathematics are assumed.

Derived Commitments

The following are consequences of A1–A3.

A4. Order exists. If a registered change is a new state, a distinction between "before" and "after" exists. This defines causal order.

A5. Time is ordering, not substance. Time arises from consistent causal orderings of registered change.

A6. Existence is persistence. Anything that exists does so only insofar as it sustains its own state across change. Endpoints without return effects do not persist and are therefore unobservable.

Space, distance, geometry, dimension, mathematics, and logic arise as further compressions of stable patterns in these orderings, as developed in §§4–7.

A.2 Non-Assumptions

This work does **not** assume:

- Space as a container.
- Time as a flowing parameter.
- Spacetime as a fundamental structure.
- Geometry as primitive.
- Dimension as intrinsic.
- Matter, mass, particles, fields, forces, or charges as ontically separate, non-electromagnetic substances or dynamics.
- Quantum postulates or probabilistic axioms.
- Mathematical objects as ontologically prior.
- Observers as fundamental entities.
- Consciousness as a primitive.

All such notions appear, if at all, only as **emergent descriptions** derived from stable cause–effect patterns.

A.3 Scope and Limits

This part makes no claims about the ultimate nature of the causal substrate. It addresses only what can be inferred from observable effects and their regularities.

Any representation constructed here remains valid only insofar as the observed patterns persist. No guarantee of uniqueness, completeness, or permanence is asserted.

A.4 Role in the Full Work

Part I establishes the ontological ground required for the later development of a Maxwell-only universe.

Subsequent parts introduce specific dynamics. Nothing in this part depends on those dynamics, and nothing in later parts modifies the assumptions listed above.

Synopsis

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A Maxwell Universe begins from a single premise: events occur.

Registered change creates order. From cause–effect relations alone emerge time, distance, space, dimension, mathematics, and physical law. No spacetime is assumed. No fixed rules are imposed. The underlying substrate, if any, is never accessed directly—only the regularities in its effects are observed and compressed into models.

The first part of A Maxwell Universe establishes this foundation. It prepares the ground for later volumes, where matter, mass, and charge appear not as fundamental point-entities, but as extended, self-sustaining electromagnetic configurations governed entirely by Maxwell dynamics.