Chronology-First Ontology:

Existence as Ordered Correlation

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Abstract

This paper presents a chronology-first ontology that extends the Mutual Information Density Hypothesis (MIDH) by adopting different primitives: chronology (the ordering of stabilized updates) and correlation (the mutual binding of distinguishable patterns). While MIDH provides the informational foundation, this ontology uses chronology and correlation as its irreducible terms, from which time and space emerge as derivative constructs. Time becomes a parametrization over chronological sequence; space becomes the projection of correlation structure into geometry. This framework renders several classical paradoxes tractable: time travel becomes structurally incoherent rather than merely difficult, the infinity of space dissolves into undetermined correlation territory, and the relationship between micro-reversibility and macro-irreversibility finds natural resolution. We formalize the relationship $E = I \times \mathcal{C}^2$*, where existence-energy equals inertial resistance to update multiplied by correlation amplitude squared, providing a parent equation from which relativistic mechanics emerges as a special case.*

1. Introduction

Contemporary physics operates with time and space as primitive coordinates, treating them as the stage upon which physical processes unfold. General relativity welds these into a four-dimensional manifold; quantum mechanics describes evolution within this manifold. Yet both frameworks inherit deep conceptual difficulties: the measurement problem, the nature of simultaneity, the arrow of time, and the apparent incompatibility between quantum and gravitational descriptions.

The Mutual Information Density Hypothesis (MIDH) offers an alternative foundation. Rather than beginning with spacetime geometry, MIDH begins with information: specifically, with the density of mutual correlation between physical systems. Previous work has shown how MIDH reframes inertia as resistance to correlation restructuring, interprets gravitational phenomena as gradients in correlation density, and provides a reading of quantum entanglement that does not require action at a distance.

This paper extends MIDH into a complete ontological framework by identifying the minimal primitives required for any physical description. While MIDH uses mutual information density as its central quantity, the ontology developed here adopts a different set of primitives: chronology and correlation. These are not symbolic translations of MIDH's terms but represent a distinct level of analysis. We argue that these two primitives are sufficient: everything else – time, space, matter, energy, causality – emerges from their interaction.

2. Chronology Distinguished from Time

2.1 The Semantic Trap

Physics uses "time" ambiguously: as a coordinate (arbitrary), as proper time (geometric invariant), and as experienced duration (phenomenological). This conflation generates conceptual difficulties that appear deeper than they are. Asking "what happened before the Big Bang" or "can we travel back in time" treats time as a navigable dimension, when the physics itself provides no warrant for this interpretation.

We propose a clean separation. *Chronology* is the ordering of correlation commitments – the sequence in which informational updates stabilize. *Time* is any parametrization assigned to intervals between chronological events. Chronology is structural; time is descriptive. Chronology exists even without clocks; time exists only given clocks and conventions.

To be clear: this distinction does not eliminate time from physics. Time remains a valid and useful parametrization for describing physical processes. What changes is its ontological status. Time is de-primarized – moved from the category of fundamental primitive to that of derived quantity. The physical role of time is preserved; its ontological priority is not.

2.2 Proper Time as Metric Projection

In general relativity, proper time τ is defined as the integral of the spacetime interval along a worldline. This appears fundamental and invariant. But what does it measure? In MIDH terms, proper time is the metric-weighted accumulation of correlation updates along a trajectory. It encodes how much "effort" is required to maintain correlations as a system traverses a path through the correlation network.

Here "effort" has a precise meaning: the density of correlation reconfiguration along the trajectory. A path through regions of high correlation gradient requires more reconfiguration per unit of chronological advance than a path through uniform regions. Proper time measures this cumulative reconfiguration cost.

Proper time is not the underlying reality – it is how the metric encodes that reality. The underlying reality is chronological: the sequence of stabilized correlation updates. General relativity's τ is one possible parametrization; special relativity's coordinate time is another. Neither is primitive.

2.3 Implications for Relativity of Simultaneity

If chronology is the fundamental ordering, then disagreements about simultaneity become coordinate artifacts rather than deep metaphysical puzzles. Two observers disagreeing about which events are simultaneous are simply using different parametrizations of the same underlying chronological structure. What remains invariant is the causal ordering – the chronology itself.

Consider the classic example: two observers, A and B, moving relative to each other, each witnessing two lightning strikes. Observer A judges the strikes simultaneous; observer B judges one to precede the other. In the chronology-first framework, this disagreement concerns the time-parametrization each observer assigns, not the underlying sequence of correlation stabilizations. Both observers agree on what causally influences what – on the chronological ordering of events connected by possible signal propagation. Their disagreement about simultaneity reflects different slicings of the correlation network, not different physical realities.

3. Correlation as the First Object

3.1 The Bootstrap Problem

A natural objection arises: correlation is a relation between things. If no things exist yet, what is being correlated? This objection assumes that objects precede relations. We invert this assumption.

Before structure exists, there are no "things" – only possibility-space. The smallest possible "something" is not an object but a distinction: a difference, a contrast, a non-sameness that can persist. In information-theoretic terms, information requires only distinguishability and stability of that distinguishability. A difference that can remain stable counts as a primitive information unit – what constructive logic would recognize as a decidable proposition.

The first correlate is not "A relative to B" but "A ≠ not-A." This avoids infinite regress: objects would require relations to define them; relations would require distinctions to connect; but distinction itself requires only non-contradiction. The chain terminates at the level of stable difference.

Information and structure co-arise. The first stable informational difference *is* a structure. There is no intermediate substrate. A distinction is information; a stable distinction is structure; stable distinctions in relation form correlation networks.

3.2 Biunivocal Binding

A correlation is not a one-way arrow from A to B. It is a mutual constraint: A ↔ B. Each side stabilizes the other; each side defines the other; each side predicts the other. We adopt the term "biunivocal" from structural philosophy to name this two-way definitional dependence.[1]

This biunivocal character has mathematical consequences. Consider the difference between a directed link and a mutual binding:

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A → B        (one constraint)
A ← B        (one constraint)
A ↔ B        (two simultaneous constraints)
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Because each direction of constraint contributes independently to the binding, the energetic contribution of a correlation is not additive but multiplicative. Two constraints reinforcing each other do not simply sum – they form a loop whose stability scales with the product of their strengths. This is why correlation amplitude enters squared rather than linearly: the biunivocal structure inherently generates quadratic dependence.

This explains why field energies, binding energies, and potential energies throughout physics exhibit quadratic dependence on amplitude. The squaring is not arbitrary; it reflects the inherent two-way nature of correlational binding.

4. Space as Correlation Structure

4.1 Against Infinite Extension

"Infinite space" appears only when we assume a metric exists everywhere, extend that metric outward, and treat emptiness as meaningful. But if space equals correlation structure, then where no correlations exist, no adjacency is defined, no metric exists, no distance exists, no "somewhere" exists. Such regions have no ontological status.

Space is not infinite. Space is not finite. Space is *undetermined* until determination is required. Undetermined does not mean unbounded – it means not yet resolved as adjacency. The universe has only as much space as it has structure. "Beyond" the correlation network, there is no beyond – not a boundary, not a wall, not a void, just undefined relational topology.

The distinction matters: "undefined" is not "empty." Empty space would be space with nothing in it – still a spatial concept. Undefined correlation territory is not space at all. It lacks the relational structure that would make spatial predicates applicable.

4.2 Emergence of Geometry

If chronology governs update ordering, then spatial relations must update along with it. Adjacency is not fixed; distance is not primitive; locality is conditional. Geometry emerges as the current shape of the correlation network.

General relativistic curvature, in this framework, represents informational tension – gradients in correlation density across the network. Where correlation density varies sharply, the effective geometry curves. The metric tensor encodes not intrinsic spatial properties but the pattern of correlation strengths and their rates of change. Geodesics become paths of minimal correlation reconfiguration, and gravitational attraction emerges as systems following gradients toward higher correlation density.

This dissolves several cosmological puzzles. The "size of the universe" becomes meaningful only as the extent of the resolved correlation graph. Cosmic expansion is the reparametrization of geometry as correlations thin out – a MID effect, not matter moving through pre-existing space. The cosmic horizon marks not a physical wall but the limit of correlation propagation.

5. Discreteness as Emergent

MIDH proposes that discreteness is not fundamental but emergent from stability constraints. The space of possible correlation configurations is continuous – a manifold of potential states. However, only configurations that meet mutual information density thresholds achieve stable correlation. Sub-threshold configurations do not persist; they have no ontological standing within the framework.

We can express this formally. The configuration space is continuous: every possible arrangement of correlations exists as a mathematical possibility. The set of stabilized configurations is discrete: only those arrangements that cross the coherence threshold become actual. Chronology is the order in which elements of this discrete set are realized.

What appears as "process" is nothing more than **sequential stabilization**: each realized configuration redefines the boundary of what can stabilize next, not by unfolding in time, but by **altering the coherence conditions** that subsequent configurations must satisfy. The possibility space accessible at chronological step k+1 is conditioned on which configuration was stabilized at step k. Chronology is not selection from a fixed menu of possibilities; it is a **path-dependent growth** of the discrete set itself.

This reframes quantum mechanics. Planck time, Planck length, quanta, measurement events, decoherence jumps – these are not "atoms of reality" but atoms of stable correlation. They mark the resolution limit of successful stabilization, not of existence itself. Wavefunction collapse becomes a threshold event: a configuration crossing from the continuous space of possibilities into the discrete set of actualized states, thereby reshaping what configurations remain possible for subsequent stabilization.

This should be distinguished from standard quantum discreteness. Quantum eigenstates are discrete solutions to the Schrödinger equation within a given Hilbert space. The discreteness we describe is prior: it concerns which configurations – quantum or otherwise – achieve the stability required to count as realized. Quantum discreteness operates within the mathematical framework of quantum mechanics; informational discreteness defines the **ontological criterion** for what enters chronology at all.

Chronology, then, is not flow through time but the cumulative sequence of realized configurations – each stabilization **logically ordered** and **structurally conditioned** by all that precedes it.

6. Reversibility, Symmetry, and Time Travel

6.1 Why Chronology Eliminates Time Travel

Time travel requires either closed timelike curves or the ability to traverse a coordinate back to a previous physical state. Both assume time is a navigable dimension. Under chronology-first ontology, neither is coherent.

States do not "live in time"; they are the succession of stabilized correlations. There is nothing "behind" the current state to return to – updating correlation reorganizes the entire informational graph. A common misconception equates determinism with stored history, as if the universe maintains a record of past states that could be accessed. But correlation networks do not store snapshots; they maintain only current configuration. Previous configurations are not archived – they are overwritten by subsequent stabilizations.

Chronology is irreversible not because of entropy but because commitments cannot be unmade. A closed timelike curve in general relativity becomes a closed path in the metric, but it does not imply reversing the global order of correlation commitments. It is a geometric artifact with no operational meaning.

6.2 Reinterpreting Reversibility

Without time as a primitive, "reversibility" stops being a metaphysical problem. Microscopic laws are often called time-symmetric, while macroscopic phenomena are not – generating puzzles about "arrows of time." But this framing assumes time is a reversible coordinate.

In chronology-first ontology, reversibility means: given event k, can we reconstruct the configuration stabilized at $k-1$? This is a question about **information preservation**, not about running a temporal coordinate backward.

To clarify, this notion of reversibility does **not** presuppose temporal flow. It concerns the **structure of the mapping** between successive stabilized configurations:

- In **information-preserving dynamics**, the mapping from the configuration that stabilizes at k−1 to the configuration that stabilizes at k is *bijective*. No correlation distinctions are lost. Every stabilized pattern at k uniquely determines the stabilized pattern at k−1. Reversibility here means **logical reconstructability**, not temporal retracing.
- In **dissipative evolution**, stabilization at event k involves a threshold-crossing that eliminates some correlation distinctions present at k−1. The mapping is no longer bijective but many-to-one; information is discarded in the stabilization step itself. Even if the dynamical rule is deterministic, the loss of correlation distinctions makes reconstruction of k−1 from k **logically impossible**. This irreversibility is structural, not temporal.

This distinction is important for preventing a common objection: that if fundamental laws are reversible (as in classical mechanics or unitary quantum evolution), a chronology-first ontology must also treat reversibility as primitive. But in this framework, **chronology defines only the ordering of stabilized states**; it does not define the dynamics connecting them. A reversible law yields bijective mappings between stabilized events; a dissipative law yields non-bijective mappings. Both are compatible with chronology-first ontology because the ontology does not assume or deny reversibility – it **defines what reversibility means**.

Irreversibility at macroscopic scales is therefore not a paradox about the “arrow of time.” It reflects the fact that most real processes involve information loss across stabilization thresholds. When a system crosses such a threshold – e.g., when many microscopic distinctions collapse into one macroscopic state – the pre-threshold configuration is not “hidden” or “past”; it is simply **no longer recoverable as a correlation structure**. Chronology is one-way because stabilization is one-way: once distinctions that held at k−1 fail to meet viability criteria at k, they cease to exist as part of the correlation network. Commitments cannot be un-committed.

Thus, irreversibility arises from **the structure of stabilization**, not from a fundamental asymmetry in time. Chronology orders which configurations become real; whether the mapping between them is reversible depends entirely on whether the intervening stabilization preserves or discards correlation distinctions.

6.3 CPT Symmetry Without T

If T is not a fundamental symmetry but a coordinate convention, then CPT symmetry becomes CP-symmetry plus invariance under chronology reparametrization. The equations need not be symmetric under "time reversal" – they need only be structurally invariant under reversal of update ordering.

The link to chronology is this: reparametrizing chronology means relabeling the sequence of stabilized updates without changing their order. Invariance under such reparametrization is a weaker condition than invariance under time reversal, because it does not require the dynamics to be unchanged when the sequence is run backwards – only when the labels assigned to sequence positions are transformed. This resolves conceptual difficulties in quantum field theory without modifying its empirical predictions.

6.4 Unitarity as Potential Symmetry, Not Realized Symmetry

A common objection to any non-temporal ontology is that fundamental physics is "reversible," because quantum dynamics is unitary. This objection arises from conflating two distinct categories: the evolution of the continuous manifold of possible configurations and the stabilization of discrete configurations that enter chronology.

Unitarity applies to the first category only. A unitary operator U implements a bijective map on the space of possible states: it preserves amplitudes, ensures probability conservation, and admits an inverse U^{-1}. This means that, at the level of the continuous configuration manifold, the dynamics is potentially symmetric: if one considers the full superpositional structure before any stabilization, the mapping between potential configurations is formally reversible.

However, chronology does not track the evolution of possibilities. Chronology records only the sequence of stabilized configurations – those that cross the coherence threshold and acquire ontological standing. Stabilization is not unitary. It is a selection operation: it discards distinctions that fail to meet viability criteria and registers only those correlations that hold. Once a stabilization occurs, the sub-threshold distinctions that existed in the continuous manifold are not preserved; they are not "hidden" or "in the past" – they simply never enter chronology. The mapping from the stabilized configuration at $k-1$ to the stabilized configuration at k is therefore not generally invertible.

In this ontology, the irreversibility of realized configurations does not contradict the reversibility of the underlying unitary dynamics, because the two concern different layers of description:

- **Continuous layer (possibility-space):** The dynamics is unitary and therefore potentially reversible. Symmetries such as CPT apply to this layer.
- **Discrete layer (chronology):** Stabilization is non-unitary, path-dependent, and not generally invertible. Irreversibility here reflects information loss across threshold crossings.

Thus, unitarity guarantees the reversibility of potential evolution, not the reversibility of realized evolution. Chronology is defined not by the unitary flow of the wavefunction but by the cumulative sequence of stabilization events, each of which constitutes a commitment that cannot be undone. This distinction dissolves the objection that a chronology-first ontology must conflict with time-reversal invariance or CPT symmetry: the symmetries apply to the continuous domain of possibilities, while chronology governs the discrete domain of actualized states.

7. The Fundamental Energy Relation

7.1 Notation

Before proceeding, we clarify notation. In this ontology, $\mathcal{C}$ (calligraphic C) denotes correlation amplitude – the strength of biunivocal binding within a system. This is an amplitude measure, not a capacity measure (as the C in μ(C) in the first MIDH paper); it quantifies binding strength rather than channel throughput. When $\mathcal{C}$ is interpreted physically as the maximum correlation propagation rate, it corresponds to c (the speed of light) in standard notation.

7.2 Deriving $E = I \times \mathcal{C}^2$

If the ontology reduces to chronology and correlation, we can express total correlational energy as the product of two factors. Let I (inertia) denote the energetic resistance to correlation update – the cost of altering a structure under chronological pressure. Let $\mathcal{C}$ (correlation amplitude) denote the strength of biunivocal binding within a system.

Why does inertia equal resistance to correlation update? In MIDH, a system's persistence depends on maintaining internal mutual information density above environmental density. Any change to the system requires reconfiguring these internal correlations. The more tightly bound the correlations, the more energy required to reconfigure them. This resistance to reconfiguration is precisely what we experience as inertia – the tendency of systems to maintain their current state.

Because correlation is inherently mutual (A ↔ B), its contribution scales quadratically, as established in Section 3.2. The fundamental relation is therefore:

$$\mathbf{E = I \times \mathcal{C}^2}$$

This is not Einstein's equation in disguise – it is the parent equation from which Einstein's emerges. In MIDH, mass is not primitive; it is the cost of maintaining internal correlation stability. The speed of light c is the maximum rate at which correlations can synchronize. When we interpret I as rest inertia (what physics calls mass) and $\mathcal{C}$ as the maximum correlation propagation constant (c), we recover:

$$\mathbf{E = mc^2}$$

Einstein's formula is thus revealed as a special case: the projection of the general existence-energy relation onto the domain where inertia manifests as mass and correlation propagation manifests as light speed.

7.3 Physical Interpretation

In this ontology, energy is not a substance but a measure of how correlation structures are configured and how costly they are to maintain or change. It has two complementary aspects:

- **Structural tension** – the cost of sustaining a given configuration (capturing rest energy and potential energy).
- **Restructuring cost** – the cost of reconfiguring correlations as chronology advances (capturing kinetic, thermal, and radiative energy).

Inertia is structural stiffness: resistance to correlation update. Correlation amplitude $\mathcal{C}$ encodes how strongly the parts of a system bind each other. The term $\mathcal{C}^2$ reflects the two-way (biunivocal) reinforcement of this binding. Thus, the quantity $E = I \times \mathcal{C}^2$ measures the total configuration cost of the system – how much correlation must be preserved or reconfigured for the system to persist.

This framework remains compatible with standard physical expressions of energy:

- **Field energies** (electric, magnetic, scalar fields) depend on amplitude squared because field amplitudes represent correlation gradients; their energy is the cost of maintaining or propagating those gradients.

- **Kinetic energy** reflects the continual reconfiguration of correlations as an object changes position; motion is not translation through space but internal correlation updates required to maintain coherence under changing relational constraints.
- **Thermal energy** reflects how many micro-level correlation configurations are accessible to the system. Temperature measures how widely the system explores this configuration space; entropy measures how dispersed those accessible configurations are.
- **Quantum energy eigenvalues** arise from stable correlation patterns in Hilbert space; the Hamiltonian generates changes in correlation structure.
- **The stress–energy tensor in GR** represents the distribution of both correlation tension (stored structure) and correlation flow (propagating restructuring), making curvature gradients interpretable as gradients in correlation density.

Seen this way, the equivalence $E = mc^2$ follows naturally. Rest mass is the inertial resistance of a highly coherent correlation structure; c is the maximal correlation propagation rate. Their product gives the total correlation cost encoded by that structure. Energy is not a substance but a measure: the cost of what a system holds together and what it takes to reconfigure.

8. The Limit of Explanation: Primum

Any ontological reduction must terminate somewhere. We have reduced time to chronology, space to correlation structure, mass to inertial resistance, energy to correlational tension. But what grounds chronology and correlation themselves?

The only coherent answer is: the bare possibility of self-consistent patterns. Before any structure, before any correlation, there must be the condition that makes correlation *possible* – a grammar of consistency, a constraint that forbids contradiction and thereby permits coherence.

We call this *primum*: not a first mover (*primum movens*), but the precondition for movement to be possible. Primum is not an entity, not a substance, not an ontic object. It is modal: it concerns what can be, not what is. Primum is the root fact that at least one consistent pattern can exist. From this, everything follows: the first stable distinction is the first information, which is the first structure, which generates adjacency, which projects as geometry.

Primum cannot be explained because explanation presupposes it. Every explanation requires a grammar – rules of inference, conditions of coherence, standards of consistency. But primum *is* that grammar. To ask "why primum?" is to request an explanation using the very framework that primum constitutes. The question is not unanswerable due to ignorance; it is structurally ill-formed. This is the ceiling of intelligibility – not because intelligence is limited, but because "beyond" has no meaning when applied to the condition that makes meaning possible.

9. Conclusion

We have presented a chronology-first ontology extending MIDH. The minimal primitives are chronology (ordered stabilization of updates) and correlation (biunivocal binding of distinctions). Time emerges as parametrization over chronology; space emerges as the projection of correlation structure; matter and energy emerge as manifestations of inertial resistance and correlational tension.

This framework dissolves rather than solves several classical problems. Time travel is rendered structurally incoherent rather than merely forbidden. The infinity of space is revealed as undetermined correlation territory. The tension between micro-reversibility and macro-irreversibility reflects information dynamics across stabilization thresholds.

The fundamental energy relation $E = I \times \mathcal{C}^2$ provides a parent equation from which relativistic mechanics emerges as a special case. Einstein's mass-energy equivalence is thereby explained rather than postulated.

Most significantly, this ontology grounds physics in information theory without requiring a substrate for information to inhabit. Correlation is not "correlation of" pre-existing things; correlation is the first thing. Structure crystallizes from consistency constraints the way patterns emerge from mathematical necessity. The universe is not a container with contents but a self-updating coherence graph – not running in space, not running through time, but running as the recursive stabilization of distinguishable relations.

The ontological hierarchy can be summarized:

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PRIMUM (modal ground)
    ↓ enables
DISTINCTION (stable difference)
    ↓ stabilizes into
CORRELATION (𝒞)
    ↓ ordered as
CHRONOLOGY
    ↓ projected as
TIME / SPACE / ENERGY
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Existence, in its most reduced form, is the history of differences that held.

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[1] The term "biunivocal" derives from structural philosophy, particularly Deleuze's use of the concept to describe reciprocal determination. In this context, it names the property of correlations whereby each term mutually defines and constrains the other, in contrast to unidirectional relations.

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