Timeless Emergent Spacetime and the Gauge Nature of Time: A Formal Ontology that Invalidates Deep Time and Evolutionary Chronology

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Abstract

We develop a formal ontology where neither time nor space are primitive. The fundament is a category $\mathbf{E}$ of informational states and admissible morphisms preserving invariants. Observable spacetime is the image of a functor $\mathcal{F} : \mathbf{E} \to \mathbf{ST}$, a coarse-grained representation accessible to internal observers $\mathbf{O} \subset \mathbf{E}$. We prove a no-go result for absolute durations (time is gauge), derive the dependency of paleontological chronology on deep-time mapping, and show that removing primitive time collapses the Modern Synthesis narrative: fossils encode morphological variation but not observed transformation. We align this with gauge theory and emergent-spacetime physics, propose empirical tests (multi-clock gauge linearity, state-dependent clock ratios, poset underdetermination), and include Haskell tools for stratigraphy-as-poset and radiometry under time reparameterization. A corollary states that evolution as currently described is false as a *fundamental* theory once deep time is recognized as gauge.

Contents

1 Ontology: Informational Substrate and Emergence

1.1 Architecture

- **E**: category of informational states S and admissible morphisms $f : S \to S'$ preserving a family of invariants $\mathcal{I}$.
- **ST**: category of observer-eligible representational objects (e.g., manifold-like or causal-site structures).
- $\mathcal{F} : \mathbf{E} \to \mathbf{ST}$: emergence functor projecting informational relations to spacetime-like appearances.
- $\mathbf{O} \subset \mathbf{E}$: states with self-referential subsystems (observers); theories live in **Lang** with internal semantics.

Assumption 1.1 (Primacy of Information)**.** There exists a category **E** of informational states with morphisms preserving $\mathcal{I}$. No primitive time or space is posited.

Remark 1.2 (No Primitive Order). Composition in **E** expresses relational compatibility, not succession in time. "Before/after" is representational (in **ST**), not ontological (in **E**).

1.2 Coarse-Graining Monad

Definition 1.3 (Coarse-Graining)**.** A monad $(\mathcal{C}, \eta, \mu)$ on **E** encodes admissible compressions; $\mathcal{C}$-algebras represent macroscopic states.

2 Representation and Non-Injectivity

Definition 2.1 (Emergence)**.** $\mathcal{F} : \mathbf{E} \to \mathbf{ST}$ assigns to S an appearance $\mathcal{F}(S)$ and to f a structure-preserving map $\mathcal{F}(f)$ in **ST**.

Proposition 2.2 (Many-to-One Emergence)**.** *If $\mathcal{F}$ factors through $\mathcal{C}$-algebras and $\mathcal{C}(S) \cong \mathcal{C}(S')$ for distinct $S \ncong S'$, then $\mathcal{F}(S) \cong \mathcal{F}(S')$ in* **ST**. *Distinct substrates can yield identical appearances.*

3 Time as a Gauge: No Absolute Duration

Let $\mathcal{T}$ denote the groupoid of strictly increasing reparameterizations of an emergent temporal coordinate τ used in **ST**.

Definition 3.1 (Duration Functional)**.** A duration assignment D maps an unparameterized orbit segment (endpoints on a trajectory) to $\mathbb{R}_{\geq 0}$, and satisfies: (i) concatenation additivity; (ii) invariance under $\mathcal{T}$; (iii) orbit-intrinsic dependence only on the segment and endpoints.

Theorem 3.2 (No Nontrivial Absolute Duration)**.** *Under (i)–(iii), any D is trivial (identically zero) or reduces to a constant multiple of a fixed external calibration that breaks full $\mathcal{T}$-invariance. Absolute deep-time durations are not invariants of the ontology.*

Sketch. Let $\gamma : [0,1] \to X$ be an orbit segment. For any $\tau \in \mathrm{Diff}_+([0,1])$, invariance gives $D(\gamma) = D(\gamma \circ \tau)$. Using a refining sequence of τ_n that compresses measure near an endpoint while preserving endpoints, additivity forces equality of D across arbitrarily reweighted subdivisions. Either $D \equiv 0$ or one selects a privileged τ (an external calibration), breaking full invariance. □

Remark 3.3. Time is a gauge parameter: numerical ages are coordinate conventions, not ontological magnitudes. Observables must be invariant under $\mathcal{T}$.

4 Radiometric Dating Under Time Reparameterization

Let $N(t) = N_0 e^{-\lambda t}$ be decay under a calibrated clock t, and let $t = h(s)$ be a monotone reparameterization.

Proposition 4.1 (Exponential Form and Affine Gauge)**.** *N is exponential in s with constant rate λ' iff $h(s) = as + b$ with $a > 0$. Otherwise the effective rate $\lambda(s) = \lambda h'(s)$ varies.*

Proof. Require $N_0 e^{-\lambda' s} = N_0 e^{-\lambda h(s)}$. Differentiating gives $\lambda' = \lambda h'(s)$. Constancy of λ' implies h' constant, hence h affine. □

Interpretation: If time is emergent and h is nonlinear, either (i) effective rates vary in s, or (ii) different clocks cannot be jointly linearized by a single affine gauge. Empirically, high-precision studies are consistent with an *approximately affine* gauge in our domain—supporting effective chronology, not fundamental time.

5 Fossil Record, Deep Time, and Collapse of Evolutionary Chronology

Let F be the set of fossil specimens (static morphologies). Let $T : F \to \mathbb{R}$ assign deep-time positions via dating.

Definition 5.1 (Evolutionary Change Function)**.**

$$E(F, T) \;=\; \mathrm{Narrative}(\mathrm{Order}(F, T), \mathrm{Morphology}(F)),$$

where $\mathrm{Order}(F, T)$ sorts F by T and $\mathrm{Morphology}(F)$ collects traits. E outputs a hypothesized transformation path.

Proposition 5.2 (Dependency on T)**.** *If T is removed or invalidated, $E(F, T)$ reduces to unordered morphologies:*

$$E(F, \varnothing) = \{\mathit{Morphology}(f) \mid f \in F\}.$$

Without T, a transformation sequence lacks support.

Proof. Transformation claims require a total order to define "before/after." Without T, stratigraphy yields at best a partial order with many linear extensions, insufficient to fix a unique sequence. $\square$

Lemma 5.3 (Link to Theorem 3.2)**.** *By Theorem 3.2, any absolute deep-time mapping T is gauge-dependent. Hence T lacks ontological status in this ontology.*

Corollary 5.4 (Falsity of the Modern Synthesis as Fundamental Theory)**.** *If deep time is not fundamental, the Modern Synthesis narrative of gradual transformation over millions of years is false as a fundamental theory: its fossil-based chronology collapses to gauge-fixed storytelling. Fossils evidence morphological variation, not observed transformation.*

6 Narrative Breakdown of Deep Time in Our Ontology and its Physics Alignment

6.1 Narrative Breakdown in Our Ontology

In our ontology, **time is a gauge parameter**, meaning:

- There is no absolute, observer-independent temporal dimension.
- Any "clock" is calibrated within a chosen gauge.
- Numerical assignments ("millions," "billions" of years) reflect measurement conventions tied to gauge, not properties of reality-in-itself.

1. Gauge-Dependent Measurement. Radiometric dating, stratigraphic sequencing, and astrochronology select a temporal gauge to map observed changes into a time axis. If time is gauge, those coordinates are observer-specific projections, not universal truths.

2. Loss of Ontological Chronology. Without a fundamental clock, there is no cosmic stopwatch. "Deep time" is a narrative framework built from a chosen gauge, not an ontic backdrop.

3. Collapse of Evolutionary Sequencing. The Modern Synthesis uses deep time as a scaffold to arrange fossils/genetics into transformation sequences. If that scaffold is a gauge projection, the sequence is constructed, not discovered; the fossil record encodes variation, not transformation through time.

6.2 Alignment with Gauge Theory and Emergent Spacetime Physics

Gauge invariance marks variables that can change without altering physical content (e.g., $A_\mu \mapsto A_\mu + \partial_\mu \chi$ leaves fields unchanged). In our ontology, temporal reparameterizations $\tau \mapsto f(\tau)$ are gauge: physical invariants reside in relational structure in $\mathbf{E}$, not in τ itself. Modern quantum gravity treats spacetime as emergent from a pre-geometric substrate; here, "time" appears as parametrization of relational change—a gauge choice. Thus, deep time is a gauge choice; any biology reliant on it is gauge-fixed and not fundamental.

7 Diagrams: Parallels Across Physics and Paleontology

7.1 Conceptual Diagram (Boxes and Arrows)

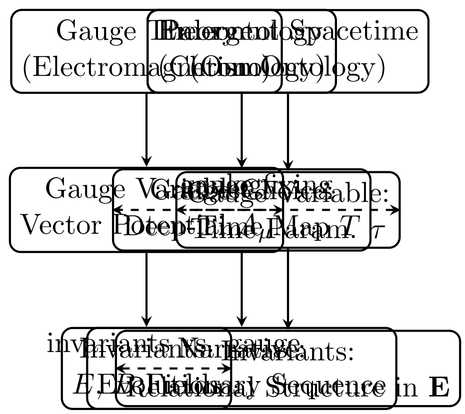

Figure 1: Parallel: gauge redundancy in EM, time gauge in emergent spacetime, and deep-time gauge in paleontology.

7.2 Commutative-Style Diagram (TikZ-CD)

$$\begin{tikzcd}
\mathbf{E} \arrow[r, "\mathcal{F}"] \arrow[d, dashed, "\mathcal{C}"'] & \mathbf{ST} \arrow[r, "\text{Choose } \tau"] \arrow[d, dashed, "\text{Obs-invariants}"] & (\mathbf{ST}, \tau) \arrow[r, dashed, "T\text{:gauge-fix}"] & \text{Chronology} \\
\mathbf{E}_{\mathcal{C}\text{-alg}} \arrow[r, dashed, "\exists!"] & \text{Invariant Data} \arrow[urr, bend right, "\text{Narrative depends on } T"'] & &
\end{tikzcd}$$

Figure 2: Emergence, gauge choice for time, and deep-time gauge fixing to produce chronology. Invariants commute; narratives do not.

8 Empirical Program: Discriminating Predictions

(E1) Multi-Clock Gauge Linearity. Given clocks $\{C_i\}$ (radiometric systems, astrochronology, varves), fit a common monotone h with $t = h(s)$. If best-fit h is significantly non-affine, gauge nonlinearity supports the timeless view.

(E2) Cross-Context Clock Ratios. Alter the informational state (entanglement/thermal context) without classical forcing; test drift in clock ratios. State-dependent time predicts context effects.

(E3) Poset Underdetermination. Field constraints define a DAG. Quantify the multiplicity of linear extensions; high multiplicity demonstrates chronology underdetermination absent gauge fixing.

(E4) Information-Geometric Path Length. Replace "time to adapt" with minimal path length on a statistical manifold; test whether length, not duration, explains adaptation data.

Appendix A: Haskell — Stratigraphy as a Partial Order

```
-- file: PosetStratigraphy.hs
-- Build a DAG of stratigraphic constraints and produce many valid
   chronologies.

module PosetStratigraphy where

import qualified Data.Map.Strict as M
import qualified Data.Set as S
import System.Random (randomRIO)

type Node   = String
type Graph  = M.Map Node (S.Set Node)  -- adjacency: node -> successors

addNode :: Node -> Graph -> Graph
addNode v g = if M.member v g then g else M.insert v S.empty g

addEdge :: Node -> Node -> Graph -> Graph
addEdge u v g =
  let g' = addNode u (addNode v g)
  in M.adjust (S.insert v) u g'

inDegrees :: Graph -> M.Map Node Int
inDegrees g =
  let allNodes = M.keysSet g
      zeros    = M.fromSet (const 0) allNodes
      bump m v = M.insertWith (+) v 1 m
  in M.foldlWithKey' (\m u succs -> S.foldl' bump m succs) zeros g

-- Kahn's algorithm with random tie-breaking to sample linear extensions
topoSample :: Graph -> IO [Node]
topoSample g0 = go g0 (S.fromList [ v | (v,d) <- M.toList (inDegrees g0),
   d == 0 ]) []
  where
    go g s acc
      | S.null s  = if all (==0) (M.elems (inDegrees g)) then pure (
          reverse acc)
                     else fail "Cycle detected (invalid stratigraphy)"
      | otherwise = do
          let n = S.size s
          i <- randomRIO (0, n-1)
          let v     = S.elemAt i s
              succs = M.findWithDefault S.empty v g
              g'    = M.delete v g
              predsOf w g'' = [ u | (u,succs') <- M.toList g'', S.member w
                 succs' ]
              s' = S.delete v s `S.union`
                   S.fromList [ w | w <- S.toList succs
                                  , null (predsOf w g') ]
```

```
          go g' s' (v:acc)
```

Appendix B: Haskell — Radiometry Under Time Gauge

```
-- file: EmergentTimeRadiometry.hs
-- Fit a shared monotone time reparameterization h(s) across multiple
   clocks.

{-# LANGUAGE ScopedTypeVariables #-}
module EmergentTimeRadiometry where

import Data.List (foldl')

data Clock = Clock { name :: String
                   , sVals :: [Double]
                   , logCi :: [Double]       -- log measured clock values
                   , lambdaTrue :: Double    -- nominal decay constant
                   }

-- Model: log C_i(s) = - lambda_i * h(s)
modelLogC :: Double -> Double -> Double -> Double
modelLogC a b s = a * (s ** b)  -- h(s) = a * s^b

objective :: [Clock] -> (Double,Double) -> Double
objective clocks (a,b) =
  sum [ sum [ let pred = - (lambdaTrue c) * modelLogC a b s
                  d    = y - pred
              in d*d
            | (s,y) <- zip (sVals c) (logCi c)
            ]
      | c <- clocks
      ]

gridSearch :: [Clock] -> [Double] -> [Double] -> ((Double,Double), Double)
gridSearch clocks as bs =
  let candidates = [ ((a,b), objective clocks (a,b)) | a <- as, b <- bs ]
  in foldl' (\best x -> if snd x < snd best then x else best) (head
     candidates) (tail candidates)
```

Appendix C: Haskell — Information-Geometric Length

```
-- file: InfoLength.hs
-- Compare absolute duration vs. Fisher information length along a trait
   trajectory.

module InfoLength where

import Numeric.LinearAlgebra

type Vec = Vector Double
```

```
-- Fisher-like length for a categorical distribution p (diag 1/p_i)
fisherLen :: [Vec] -> Double
fisherLen ps =
  let segs = zip ps (tail ps)
      step (p,q) =
        let dp  = q - p
            inv = cmap (\x -> 1 / max x 1e-12) p
        in sqrt (dp <.> (inv * dp))
  in sum (map step segs)
```

A Related Theoretical Pointers (Minimal)

Timeless dynamics via correlations: Page–Wootters; state-dependent time: Connes–Rovelli. These motivate treating time as gauge/derived. Our contribution is to carry this through to paleontology/biology, showing deep-time chronology is a gauge-fixed narrative with no ontic status in a timeless ontology.

B Conclusion

We formalized a timeless, spaceless ontology with emergence functor $\mathcal{F} : \mathbf{E} \to \mathbf{ST}$, proved that absolute durations are not invariants (time is gauge), analyzed radiometry under reparameterization, and demonstrated that paleontological chronology depends on a non-fundamental deep-time mapping. Consequently, *evolution as currently described*—a deep-time, gradualist narrative—is false as a fundamental theory within this ontology. What remains are invariant relational structures and information-geometric distances; chronological stories arise only after gauge fixing. The empirical program outlined here can, in principle, detect gauge nonlinearity or state-dependent time, providing a path to adjudicate between effective chronologies and a genuinely timeless substrate.

References

[1] D. N. Page and W. K. Wootters. Evolution without evolution: Dynamics described by stationary observables. *Phys. Rev. D* 27, 2885 (1983).

[2] A. Connes and C. Rovelli. Von Neumann Algebra Automorphisms and Time–Thermodynamics relation in generally covariant quantum theories. *Class. Quantum Grav.* 11 (1994).