

Invariant Temporal Ordering Framework V38/F18: Invariant Cosmic Extension, Objective Common-Stage Co-Presence, and Universal Change Continuity

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Abstract

V38/F18 defines time as the invariant universal cosmic extension and the objective, non-reversed succession of common cosmic stages of realized physical change. All qualified physical systems participate in the same single cosmic-stage succession throughout their realized identity ranges; no system possesses a private cosmic-stage succession. Each system nevertheless retains its own physical state, change, causal conditions, and physical history. Time does not cause physical change:

$$\boxed{T_{\text{ITOF}} := \mathcal{E}_C := (\mathcal{S}_C^{\text{tot}}, \prec_C).} \quad (1)$$

No admitted member of this succession is change-null or empty of realized physical change. Every admitted stage formally expresses at least one actual physical change realized by a qualified physical-system identity and its place in the objective earlier-later order:

$$\boxed{\text{RealizedChangeStage}_C(s) \iff [s \in \mathcal{S}_C^{\text{tot}}] \wedge \exists A \in \mathcal{U}_{\text{phys}} [s \in I_A \wedge \text{PhysReal}_A^+(s)].} \quad (2)$$

This is the minimal stage-admission condition requiring actual physical change in at least one qualified physical system: non-system factor realization alone does not admit a cosmic stage, and the condition does not by itself require every qualified system realized at s to change. A stage is a formal stage expression, not a container, physical state, change packet, causal agent, clock reading, coordinate, metric interval, or private system time. Realized change may be observed, unobserved, or below a detection threshold.

Strict Cosmic Ordering constrains the designated objective earlier-later relation as a strict total order. Non-reversal means that $r \prec_C s$ never becomes $s \prec_C r$. This does not imply equal stage spacing, metric duration, a universal rate of change, or identical physical evolution. Physical recurrence or reversal of a physical variable does not reverse the cosmic succession.

The Cosmic Moment Axiom (CMA) states common-stage unity: at every admitted cosmic stage, the complete then-realized qualified physical-system population is objectively co-present at that

same common cosmic stage:

$$\boxed{\text{CMA} \iff \forall s \in \mathcal{S}_C^{\text{tot}} : \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s).} \quad (3)$$

CMA does not require equal states, changes, rates, causes, locations, clock readings, or physical histories. It excludes system-private ITOF cosmic-stage successions.

Universal Change Continuity (UCC) is a separate foundational physical postulate:

$$\boxed{\text{UCC} \iff \forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A : \text{PhysReal}_A^+(s).} \quad (4)$$

UCC states that each qualified physical system realizes its own system-specific physical change at every admitted member of its realized identity range. CMA and UCC are logically distinct; their conjunction supplies the full common-stage all-system change condition.

Non-Terminating Cosmic Succession remains an optional cosmological condition, not part of the definition of time and not a consequence of CMA or UCC. The physical universe is a non-container totality of physical-system identities and physically realized physical factors. Physical causation remains supplied by independently warranted physics; time, stage order, CMA, and UCC are not causal mechanisms. Observation, records, clocks, coordinates, proper-time quantities, and operational metrics remain physical or representational constructions and do not constitute time in ITOF.

Identity formation, persistence, ending, and successor attribution remain separately typed. Ending need not produce a successor, and absorption into a pre-existing system does not create a new successor identity. Quantitative or empirical discrimination requires an independently specified physical-to-observable bridge; ontological difference alone supplies no observable residual.

The framework does not claim that CMA is derived from Lorentzian geometry or that a preferred spacetime foliation follows from the formal domain of cosmic stages. Any association between ITOF stages and spacetime event sets is additional application structure whose symmetry and empirical consequences must be independently specified. Likewise, an exact quantum stationary-state representation is not counted as physical change merely because its state vector acquires a global phase: a complete, independently warranted case of physical non-change in a qualified system would be a direct countercondition to UCC. V38/F18 currently claims no standalone foundation-specific quantitative residual from temporal ontology alone; any future discrimination claim must exhibit a bridge-robust observable separation attributable to a stated foundational difference.

Keywords: ITOF; time; universal cosmic extension; cosmic physical totality; physical factors; invariant cosmic ordering; invariant cosmic succession; non-terminating cosmic succession; common cosmic change stages; Cosmic Change-Stage Population Principle; Cosmic Moment Axiom; objective common-stage co-realization; complete-population change realization; Universal Change Continuity; foundational dependency architecture; system-specific physical change; complete-population physical-realization profile; physical-system identity qualification; hierarchical physical systems; identity-bounded physical history; conditional direct-successor production; successor identity; causal realization; system-relative external physical response; criterion-relative physical impact; operational metric construction; quantitative bridge architecture; predictive separation; Exact-Change-Stage Restraint; Non-Transfer Principle; relativistic temporal identification.

Authorship and Intellectual Provenance

The Invariant Temporal Ordering Framework was conceived and developed by Youssry Ghandour through independent research. V38/F18 is the current formulation and supersedes incompatible formulations in earlier versions. Earlier versions remain historical records and do not govern where they conflict with V38/F18. V37/F17 is the immediate predecessor [1].

Computational and artificial-intelligence-assisted tools were used only as supporting instruments for language refinement, document organization, consistency checking, numerical verification, typesetting, and editorial review. The conceptual ideas, theoretical architecture, definitions, original hypotheses, scientific analyses, formal judgments, interpretive positions, innovations, and final scientific and publication decisions in V38/F18 are the work and responsibility of Youssry Ghandour. No computational or artificial-intelligence system is presented as an author, originator of ITOF, independent scientific authority, evidentiary source, or substitute for author responsibility.

1. Governing Foundation of V38/F18

1.1 Foundational scope of V38/F18

V38/F18 fixes three foundational roles that must not be conflated:

$$\begin{aligned} T_{\text{ITOF}} &= \text{the one universal ordered extension of objectively realized physical change,} \\ \text{CMA} &= \text{the objective common-stage co-presence commitment,} \\ \text{UCC} &= \text{the universal system-specific physical-change continuity commitment.} \end{aligned} \tag{5}$$

The first fixes the meaning of time and stage semantics. The formal cosmic-stage domain architecture supplies one cosmic-stage domain. CMA independently asserts objective co-presence of the complete then-realized qualified population at the same common stage. UCC independently asserts actual system-specific physical change throughout every realized identity range. Neither is a causal law, and neither supplies a dynamical equation.

Time denotes the invariant universal cosmic extension fixed above. Formally,

$$T_{\text{ITOF}} = \mathcal{E}_C = \left(\mathcal{S}_C^{\text{tot}}, \prec_C \right). \tag{6}$$

Physical states, physical-change contents, causal sets, records, observables, metrics, dynamics, and application models are not additional members of this ordered pair.

1.2 Version status

V37/F17 is the immediate predecessor [1]; the wider V14–V37 sequence is documented in the consolidated project and archive record [3]. V38/F18 is governed by the definitions, axioms, postulates, principles, constraints, and derived results stated in this version. Earlier formulations have historical status only.

1.3 Statement-status discipline

V38/F18 distinguishes

$$\begin{aligned} & \text{Definition, Axiom, Postulate, Principle, DerivedCondition,} \\ & \text{Proposition, Construction, ApplicationPremise, EmpiricalBridge.} \end{aligned} \quad (7)$$

A defined construction adds no primitive physical commitment. A derived condition is available only from its declared premises. A typed object is not a proposition merely because it occurs in an equation. An application premise does not become a temporal axiom through empirical success. In V38/F18, every non-definitional and non-derived ontological, physical, causal, or identity commitment is stated as an axiom or postulate. Constitutive content fixed directly by a governing definition is not an additional axiom or postulate. The “principle” environment is reserved for type, non-transfer, epistemic, or methodological constraints whose status is declared explicitly in the status register; it is not used to conceal an additional ontological postulate.

The symbol $\not\vdash$ is reserved for formal non-derivability supported by an explicit model-theoretic or proof-theoretic argument. Ordinary non-sufficiency, non-transfer, observational insufficiency, or lack of automatic implication is written with $\not\Rightarrow$.

1.4 Framework and Time

The framework contains physical, identity, causal, observational, and application objects in addition to the temporal ordered pair. Schematically,

$$\mathfrak{F}_{38} = \langle T_{\text{ITOF}}, \mathcal{U}_C^{\text{phys}}, \mathcal{U}_{\text{phys}}, \mathfrak{F}_{\text{phys}}, \{\mathfrak{R}_C(s)\}_{s \in \mathcal{S}_C^{\text{tot}}}, \{\mathcal{H}_A\}_{A \in \mathcal{U}_{\text{phys}}}, \mathfrak{K}, \mathfrak{M}_{\text{phys}}, \mathfrak{M}_{\text{op}}, \mathfrak{D} \rangle. \quad (8)$$

The type boundary is

$$T_{\text{ITOF}} \not\equiv_{\text{def}} \mathfrak{F}_{38}. \quad (9)$$

2. Time and Cosmic Succession

2.1 Governing definition

Definition 2.1 (Time). Time denotes the invariant universal cosmic extension and the objective, non-reversed succession of common cosmic stages of realized physical change. All qualified physical systems participate in the same single cosmic-stage succession throughout their realized identity ranges; no system has a private cosmic-stage succession. Each system retains its own physical state, change, causal conditions, and physical history. No admitted member of the succession is change-null or empty of realized physical change; every admitted stage formally expresses at least one actual physical change.

Invariant means that the designated earlier–later order is objective and fixed. *Non-reversed* means that if $r \prec_C s$, the governing order never becomes $s \prec_C r$. A change of observer, coordinate, clock, synchronization convention, signal, measurement, description, or physical condition does not reverse that order. Physical recurrence, cyclic evolution, or reversal of a physical variable does not reverse cosmic succession.

The formal definition is

$$\boxed{T_{\text{ITOF}} := \mathcal{E}_C := (\mathcal{S}_C^{\text{tot}}, \prec_C).} \quad (10)$$

Here $\mathcal{S}_C^{\text{tot}}$ is the one universal formal domain of cosmic stages and $\prec_C$ is its designated objective earlier–later relation.

Equation (10) is a formal definition. It specifies the one universal formal domain of cosmic stages and its designated objective earlier–later relation. It does not add a physical substance, container, causal entity, or separate set-theoretic object to physical reality. Physical systems, states, change contents, and causal structures remain independently typed.

The definition supplies one formal domain of cosmic stages $\mathcal{S}_C^{\text{tot}}$ and one governing earlier–later relation. Every qualified identity range I_A is represented within that formal cosmic-stage domain. This formal single-domain structure does not by itself establish the objective co-presence asserted by CMA.

The invariance of succession does not imply equal stage spacing, constant metric duration, a universal rate or magnitude of physical change, identical dynamics, or identical physical histories. Time is not matter, energy, mass, force, field, radiation, signal, physical substance, medium, container, physical system, causal source, interaction, dynamical mechanism, physical state, or physical-change content. It is not a clock, clock reading or rate, coordinate, coordinate time, proper-time functional, metric or spacetime interval, reference frame, synchronization or simultaneity convention, foliation, trajectory parameter, frequency standard, record, detector output, numerical duration, or measurement scale. Such quantities may describe, model, or measure physical processes; they do not constitute time in ITOF.

Time does not cause physical change, and physical change is not treated as a physical cause that produces time. Physical dynamics and causes are supplied by independently warranted physics. Requiring at least one actual physical change in a qualified physical-system identity at every admitted stage is the minimal stage-admission condition requiring actual physical change in at least one qualified physical system. Complete change actuality in every qualified system realized at a stage is stated separately by UCC, while CMA separately states objective common-stage co-presence. The definition of time does not require an infinite future; cosmic non-termination is a separate optional cosmological condition.

2.2 Spatial coordinates and temporal type separation

In ITOF, place or spatial location belongs to the geometric description of a physical system; it is not part of the ontological type of time. In a declared spatial or spacetime model with chart or frame F , the location of a qualified physical system A may be represented by a spatial coordinate tuple

$$\mathbf{x}_A^{(F)} = (x_A^{1(F)}, x_A^{2(F)}, x_A^{3(F)}), \quad (11)$$

with the dimension adapted to the declared geometry when necessary. When an application associates a system state with an admitted cosmic stage, the notation $\mathbf{x}_A^{(F)}[s]$ denotes the geometric position assigned to that system state in F ; the bracketed s indexes the ITOF stage claim and is not itself a spatial coordinate. Spatial coordinates may change under a change of chart or frame without changing the type or identity of T_{ITOF} . Likewise, a coordinate- time label t_F belongs to the geometric or model representation and is not the temporal referent defined by ITOF. The type separation is

$$\mathbf{x}_A^{(F)}[s] \not\equiv_{\text{type}} s, \quad t_F \not\equiv_{\text{type}} s, \quad t_F \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (12)$$

Thus a common cosmic stage does not mean a common spatial position, and temporal co-presence must not be reconstructed as equality of spatial coordinates.

2.3 Cosmic Stage Definition

Definition 2.2 (Cosmic stage). An admitted cosmic stage is a member $s \in \mathcal{S}_C^{\text{tot}}$ that serves as the formal stage expression of objectively realized physical change and of its position in the one common objective earlier–later succession. The stage is common as a temporal member, not as physical content: every qualified system whose realized identity range contains s is incident with that same member of the single formal domain of cosmic stages, while its state, change, causes, and history remain system-specific. Objective collective co-presence of the complete then-realized population is the separate content of CMA. Stagehood therefore excludes an admitted empty or change-null member but does not, by itself, require change in every qualified system incident there.

A cosmic stage is not a container, receptacle, physical system, physical state, change content, change packet, causal source, clock moment, clock reading, coordinate, metric interval, duration, private system time, or additional ontic ordering-position entity. The written symbol s , the member of the formal cosmic-stage domain that it designates, and the physical changes formally expressed at that member are type-distinct. Observation is not constitutive of stagehood; realized change may be observed, unobserved, or below the relevant detection threshold.

For an admitted member, minimal physical non-nullness is expressed by

$$\boxed{\text{RealizedChangeStage}_C(s) \iff [s \in \mathcal{S}_C^{\text{tot}}] \wedge \exists A \in \mathcal{U}_{\text{phys}} [s \in I_A \wedge \text{PhysReal}_A^+(s)]}. \quad (13)$$

Temporal admissibility requires this condition for every admitted member. The minimum stage-admission condition requires actual physical change in at least one qualified physical system at the admitted member. A non-system physical factor may contribute to, constrain, or mediate system change, but factor realization alone does not satisfy $\text{RealizedChangeStage}_C(s)$. This typing rule does not diminish the physical reality or causal relevance of factors. Stage admission does not by itself require complete-population change. UCC independently strengthens the change requirement to every qualified system realized at that member, while CMA independently supplies objective common-stage co-presence of that complete then-realized population. Stage membership and temporal order do not cause the physical change they formally express. In a concrete application, scientific attribution of $\text{PhysReal}_A^+(s)$ requires applicable independently warranted physics, a declared system boundary and granularity, and an admissible evidential or modelling basis. These conditions govern attribution; they do not constitute the stage or create the physical change.

2.4 One common stage domain

The formal architecture uses one formal domain of cosmic stages $\mathcal{S}_C^{\text{tot}}$ for all qualified physical-system identity ranges, with $I_A \subseteq \mathcal{S}_C^{\text{tot}}$ for every $A \in \mathcal{U}_{\text{phys}}$. It excludes a representation in which each system is assigned an independent ITOF stage domain later synchronized or identified with another. The common formal cosmic-stage domain is a formal domain condition; CMA separately asserts objective common-stage co-presence.

The constitutive dependence of admitted stagehood on objectively realized physical change is not a causal dependence. Physical change does not produce, generate, or cause time, and time

does not produce, generate, or cause physical change. V38/F18 admits a member of the formal cosmic-stage domain only where it formally expresses objectively realized physical change within the designated earlier–later succession; physical dynamics and causal production remain supplied independently by applicable physics.

2.5 Common cosmic change stage

In the full V38/F18 theory, a common cosmic change stage combines an admitted realized-change stage in the universal formal cosmic-stage domain, CMA common-stage co-presence, and UCC system-specific physical-change actuality for every qualified system realized there. The phrase adds no further entity, causal mechanism, or temporal layer.

2.6 Cosmic extent and conditional non-termination

ITOF does not build an unlimited future into the definition of time. The following order-theoretic condition is retained for cosmological models in which unrestricted continuation is independently adopted or established:

$$\boxed{\text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \iff \forall s \in \mathcal{S}_C^{\text{tot}} \exists t \in \mathcal{S}_C^{\text{tot}} (s \prec_C t).} \quad (14)$$

It states exactly that the represented succession has no greatest member. It contains no physical-change magnitude, dynamics, metric, or prediction about a particular system. Crucially, V38/F18 does not assert that present scientific knowledge fixes whether this condition holds over the complete future of the universe.

Equation (14) is non-metric. It does not assert density, adjacency, topological continuity, differentiability, equal spacing, scalar duration, or infinitesimal stage interval:

$$\begin{aligned} \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) &\not\Rightarrow \text{DenseOrder}, \\ \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) &\not\Rightarrow \text{Adjacency}, \\ \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) &\not\Rightarrow \text{TopologicalContinuity}, \\ \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) &\not\Rightarrow \text{Differentiability}, \\ \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) &\not\Rightarrow \text{EqualSpacing}, \\ \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) &\not\Rightarrow \text{MetricDuration}. \end{aligned} \quad (15)$$

A terminal stage of a particular system identity is not thereby a terminal cosmic stage. If A ends at e_A , e_A is the final member of I_A under the applicable identity criterion. Whether that same stage is also a greatest member of the complete cosmic succession is a distinct cosmological question:

$$\begin{aligned} \text{End}_A(e_A) &\not\Rightarrow \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C), \\ \text{End}_A(e_A) &\not\Rightarrow \neg \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C). \end{aligned} \quad (16)$$

Where other qualified identities persist or new qualified identities are physically formed, their later realizations remain members of the same cosmic succession; no new time or restarted temporal order is introduced.

Non-termination is also not UCC:

$$\text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \not\equiv_{\text{def}} \text{UCC}. \quad (17)$$

UCC states change throughout realized identity ranges; it does not predict that the universe possesses an unlimited future. If non-termination is additionally adopted, then the conditional extended realization satisfies

$$\begin{aligned} & \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \wedge \text{UCC} \\ & \wedge \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \\ \implies & \forall s \in \mathcal{S}_C^{\text{tot}} : \left[\exists t \in \mathcal{S}_C^{\text{tot}} (s \prec_C t) \wedge \mathcal{B}_\Delta(s) = \mathcal{S}_{\text{phys}}(s) \neq \emptyset \right]. \end{aligned} \quad (18)$$

This is a conditional statement about an unlimited cosmological extension, not a hidden assertion that current physics has established one.

2.7 Constitutive temporal admissibility

Define

$$\begin{aligned} & \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \\ \iff & [\mathcal{S}_C^{\text{tot}} \neq \emptyset] \wedge \text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) \\ & \wedge \forall s \in \mathcal{S}_C^{\text{tot}} \text{ RealizedChangeStage}_C(s) \\ & \wedge \exists r \in \mathcal{S}_C^{\text{tot}} \exists t \in \mathcal{S}_C^{\text{tot}} (r \prec_C t). \end{aligned} \quad (19)$$

This definition fixes a nonempty strictly ordered domain of actually realized physical-change stages and requires at least one nontrivial earlier–later pair, so the admitted totality represents a genuine succession rather than a succession-free singleton. The final conjunct is only a non-degeneracy condition: it neither assumes nor entails that every stage has a later member. It therefore does not settle whether the complete succession has a greatest member, specify a metric, supply system dynamics, establish CMA, or establish UCC. Temporal admissibility, CMA, and UCC retain distinct logical roles.

2.8 Designated Temporal Orientation

The notation $r \prec_C s$ has a fixed semantic role in ITOF:

$$r \prec_C s \quad \text{denotes that } r \text{ is objectively earlier than } s \text{ in the one cosmic succession.} \quad (20)$$

This designation is part of the governing meaning of the theory. Strict Cosmic Ordering does not choose one orientation from two mathematically symmetric orders; it imposes the strict-total-order properties on the relation already designated as earlier–later.

Axiom 2.3 (Strict Cosmic Ordering). The relation $\prec_C$ is the designated objective earlier–later relation on the one formal domain of cosmic stages. Its orientation is fixed and non-reversed: if $r \prec_C s$, no observer, coordinate, clock, physical condition, signal record, or convention makes s earlier than r . Strict Cosmic Ordering requires

$$\boxed{\text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C)}. \quad (21)$$

The axiom constrains order only. It does not supply stage spacing, duration, density, differentiability, a temporal rate, or physical dynamics.

For distinct $r, s \in \mathcal{S}_C^{\text{tot}}$, exactly one order direction holds:

$$r \neq s \implies [(r \prec_C s) \vee (s \prec_C r)] \wedge \neg [(r \prec_C s) \wedge (s \prec_C r)]. \quad (22)$$

In particular,

$$r \prec_C s \implies \neg(s \prec_C r). \quad (23)$$

The inverse relation is mathematically definable by

$$s \prec_C^{-1} r \iff r \prec_C s, \quad (24)$$

but mathematical definability does not make the inverse a second governing orientation:

$$\text{MathematicallyDefined}(\prec_C^{-1}) \not\Rightarrow \text{GoverningTemporalOrder}_{\text{ITOF}}(\prec_C^{-1}). \quad (25)$$

Nor does strict total ordering alone perform the semantic designation:

$$\text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) \not\Rightarrow \text{SemanticSelectionOfEarlierLaterOrientation}. \quad (26)$$

2.9 Fixedness across admissible representations

The word *fixed* does not mean physical stasis. It means that the same designated objective earlier–later relation governs every admissible temporal representation. For any representation $\rho : \mathcal{S}_C^{\text{tot}} \rightarrow R$ equipped with a represented order $\prec_\rho$, admissibility requires

$$\text{AdmissibleTemporalRepresentation}_{\text{ITOF}}(\rho, \prec_\rho) \implies \forall r, s \in \mathcal{S}_C^{\text{tot}}, \quad [r \prec_C s \iff \rho(r) \prec_\rho \rho(s)]. \quad (27)$$

Labels, coordinates, or parameterizations may change; the governing objective orientation does not.

2.10 Physical recurrence does not reverse cosmic order

A system may later realize a state equal or equivalent, under a declared criterion K_A , to a state it realized earlier. If

$$r \prec_C t \wedge K_A(X_A(r), X_A(t)) = \text{Equivalent}, \quad (28)$$

then the later occurrence remains later:

$$r \prec_C t \wedge K_A(X_A(r), X_A(t)) = \text{Equivalent} \implies r \neq t \wedge r \prec_C t \wedge \neg(t \prec_C r). \quad (29)$$

Accordingly,

$$\text{PhysicalStateRecurrence} \not\Rightarrow \text{TemporalReturn}. \quad (30)$$

A repeated physical condition is a distinct later realization in the same objective succession. It does not alter the already designated order relation between the earlier and later cosmic-stage expressions.

2.11 Universal Cosmic Extension

The universal cosmic extension does not denote spatial extension, metric duration, a material medium, a physical field, a causal carrier, or a container through which systems or changes move:

$$\begin{aligned}
\mathcal{E}_C &\not\equiv_{\text{type}} \text{SpatialLength}, & \mathcal{E}_C &\not\equiv_{\text{type}} \text{MetricDuration}, \\
\mathcal{E}_C &\not\equiv_{\text{type}} \text{CoordinateInterval}, & \mathcal{E}_C &\not\equiv_{\text{type}} \text{ProperTimeFunctional}, \\
\mathcal{E}_C &\not\equiv_{\text{type}} \text{PhysicalField}, & \mathcal{E}_C &\not\equiv_{\text{type}} \text{PhysicalMedium}, \\
\mathcal{E}_C &\not\equiv_{\text{type}} \text{PhysicalContainer}, & \mathcal{E}_C &\not\equiv_{\text{type}} \text{CausalAgent}, \\
\mathcal{E}_C &\not\equiv_{\text{type}} \text{ClockOutput}.
\end{aligned} \tag{31}$$

The stage symbols do not move through a temporal receptacle, and the temporal extension does not move from stage to stage:

$$\neg \text{Moves}(T_{\text{ITOF}}), \quad \neg \text{Moves}(\mathcal{E}_C), \quad \forall s \in \mathcal{S}_C^{\text{tot}} \neg \text{StageMovesThroughTime}(s). \tag{32}$$

Earlier and later are ordering relations, not locations through which time or a packet of change travels.

2.12 Temporal and Physical Type Separation

An admitted stage member is a formal expression of realized physical change within the one universal objective earlier–later succession. The ordered-pair signature $(\mathcal{S}_C^{\text{tot}}, \prec_C)$ does not contain physical systems, state vectors, change-content values, or physical laws as additional components. Nevertheless, the governing stage semantics requires physical non-nullness:

$$s \in \mathcal{S}_C^{\text{tot}} \implies \text{RealizedChangeStage}_C(s) \implies \exists A \in \mathcal{S}_{\text{phys}}(s) \text{PhysReal}_A^+(s). \tag{33}$$

What stage membership does not entail is complete qualified-system change coverage:

$$s \in \mathcal{S}_C^{\text{tot}} \not\Rightarrow [\mathcal{B}_\Delta(s) = \mathcal{S}_{\text{phys}}(s)]. \tag{34}$$

The global formal cosmic-stage domain fixes the formal stage domain. CMA separately supplies objective common-stage co-presence, while UCC supplies complete qualified-system actual-change coverage. This type separation does not make a stage an empty temporal placeholder; it distinguishes minimal realized-change stage meaning from the separate CMA and UCC commitments.

2.13 Order representations and non-metricity

Let $(L, <_L)$ be an ordered representation domain and let

$$\iota : \mathcal{S}_C^{\text{tot}} \longrightarrow L \tag{35}$$

be injective. It is an admissible order representation only if

$$\text{OrderRepresentation}(\iota) \iff \forall r, s \in \mathcal{S}_C^{\text{tot}}, \quad r \prec_C s \iff \iota(r) <_L \iota(s). \tag{36}$$

If f is strictly increasing, $f \circ \iota$ preserves the same governing order. A numerical interval may change under such a reparameterization, so order preservation does not produce a canonical duration:

$$\text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) \not\Rightarrow \text{CanonicalMetricIntervalOn}(\mathcal{S}_C^{\text{tot}}). \quad (37)$$

A metric, duration scale, clock scale, or numerical stage parameter requires additional physical or mathematical structure.

3. Conditional Cosmic Non-Termination

3.1 Identity ending and cosmic extent are distinct

Equation (14) defines a conditional order-theoretic property of the complete cosmic succession. It is not a foundation-level assertion that current science has established an unlimited future. Formation, persistence, ending, and successor production concern identity ranges within the one cosmic order. The terminal stage e_A of a particular identity A is therefore only the greatest member of I_A when that identity ends; it is not thereby the greatest member of $\mathcal{S}_C^{\text{tot}}$. If other identities persist or genuinely new identities form, their realizations continue in the same cosmic order.

Conversely, V38/F18 does not infer from present or ongoing physical change that $\mathcal{S}_C^{\text{tot}}$ must have no greatest member over the unknown complete future. The future extent of cosmic physical change remains a cosmological question. Where an application independently adopts $\text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C)$, all consequences of that assumption are explicitly conditional on it.

No unconditional infinity claim follows from temporal admissibility, governing CMA, or the UCC continuity condition. In particular,

$$\begin{aligned} \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) &\not\Rightarrow \text{Infinite}(\mathcal{S}_C^{\text{tot}}), \\ \text{CMA} &\not\Rightarrow \text{Infinite}(\mathcal{S}_C^{\text{tot}}), \quad \text{UCC} \not\Rightarrow \text{Infinite}(\mathcal{S}_C^{\text{tot}}). \end{aligned} \quad (38)$$

Infinite-cardinality conclusions arise only from their explicitly declared premises. In particular, temporal admissibility supplies a nonempty strict total order, while conditional cosmic non-termination supplies the no-greatest-member premise; together these imply infinitude of the stage domain. The symbol ∞ , where used in a cardinality statement below, denotes only that the relevant set is not finite; it does not select a particular infinite cardinal, entail countability, or denote a metric, duration, magnitude, or physically measured future extent.

3.2 Cosmic origin remains independent

Conditional non-termination toward later cosmic stages does not entail a least member of $\mathcal{S}_C^{\text{tot}}$. If a cosmic origin is adopted, it remains a separate cosmological commitment:

Postulate 3.1 (Cosmic Origin).

$$\boxed{\text{CosmicOrigin} \iff \exists! s_C^0 \in \mathcal{S}_C^{\text{tot}} \forall s \in \mathcal{S}_C^{\text{tot}} \setminus \{s_C^0\}, \quad s_C^0 \prec_C s.} \quad (39)$$

Thus

$$\text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \not\Rightarrow \text{CosmicOrigin}. \quad (40)$$

3.3 Reference-stage order prefix

For any admitted reference stage $a \in \mathcal{S}_C^{\text{tot}}$, define

$$\mathcal{S}_C^{\leq a} := \{v \in \mathcal{S}_C^{\text{tot}} \mid v = a \vee v \prec_C a\}. \quad (41)$$

This is a derived order prefix, not a second temporal domain, generated frontier, moving present, or presentism axiom.

4. Cosmic Physical Totality and CMA

4.1 Physical Systems, Physical Factors, and Physical Totality

Physical-system status is objective. V38/F18 uses $\text{PhysicalSystem}(A)$ for the ontic claim that A is a physically realized system with its own physical constitution, system-level properties, and physically distinguishable identity:

$$\boxed{\begin{aligned} \text{PhysicalSystem}(A) \implies & \text{PhysicallyRealized}(A) \wedge \text{PhysicalConstitution}(A) \\ & \wedge \text{SystemSpecificPhysicalProperties}(A) \\ & \wedge \text{PhysicallyDistinguishableIdentity}(A). \end{aligned}} \quad (42)$$

A scientifically warranted qualification scheme Ω does not create physical-system status. It fixes the class, boundary, granularity, and numerical- identity criteria used to identify, track, or test particular systems in a specified application. Write $\text{PhysicalSystem}_\Omega(A)$ only for the application-level claim that the objectively physical system A is admissibly qualified under Ω :

$$\text{PhysicalSystem}_\Omega(A) \implies \text{PhysicalSystem}(A). \quad (43)$$

Different physically meaningful subsystem and composite levels may support qualified identities, but arbitrary description, spatial grouping, or analytical convenience neither creates a physical system nor creates a cosmic stage.

Within V38/F18, *physical factor* is one framework category spanning physically different factor families. Each factor retains the domain-specific physical classification and mechanism assigned by the applicable physics; ITOF imposes no closed catalogue. A physical factor is the ITOF category for a physically realized non-system physical item that can enter a warranted physical description as a condition, field, process, interaction, transfer, boundary, physically realized medium condition or structure, or other non-system physical determinant.

$$\boxed{\text{PhysicalFactor}(F) \implies \text{PhysicallyRealized}(F) \wedge \neg \text{PhysicalSystem}(F).} \quad (44)$$

The condition $\neg \text{PhysicalSystem}(F)$ is an ontological type boundary within ITOF, not a claim about causal importance. A physical system that influences another system remains a physical system and is typed by $\text{InfluencingPhysicalSystem}$, not reclassified as a factor. Application boundary and granularity determine which system identity is being tracked and which external contributors are relevant; they do not convert a physical-system identity into a physical factor or a physical factor into a physical-system identity. Detailed causal families, internal contributors, external influencing systems, and qualitative causal composition are centralized in Section 8; the

present section fixes ontology and typing only.

For a declared physical system A at s , $\text{InfluencingPhysicalFactor}(F; A, s)$ means that F is outside the declared boundary of A and its actual physical influence contributes to the physical change realized in A at s . In a concrete application, scientific attribution of that influence must be warranted by the applicable physics for the declared system boundary and granularity. Thus

$$\begin{aligned} & \text{InfluencingPhysicalFactor}(F; A, s) \\ \implies & \text{PhysicalFactor}(F) \wedge \text{PhysicalSystem}(A) \wedge \text{ExistsAs}(A, s) \wedge \text{FactorRealizedAt}(F, s). \end{aligned} \quad (45)$$

Here $\text{FactorRealizedAt}(F, s)$ records stage-relative physical realization of the factor. It does not by itself assert that the factor influences a declared system or acts as a causal contributor. The full $\text{InfluencingPhysicalFactor}(F; A, s)$ relation supplies that additional causal role where independently warranted.

Define the physically realized physical-factor totality by

$$\boxed{\mathfrak{F}_{\text{phys}} := \{F \mid \text{PhysicalFactor}(F)\}}. \quad (46)$$

The stage-relative factor-realization relation is typed by

$$\text{FactorRealizedAt} \subseteq \mathfrak{F}_{\text{phys}} \times \mathcal{S}_{\text{C}}^{\text{tot}}. \quad (47)$$

Every physical factor admitted to the physically realized factor totality must have stage support in the common formal cosmic-stage domain:

$$\forall F \in \mathfrak{F}_{\text{phys}} \exists s \in \mathcal{S}_{\text{C}}^{\text{tot}} : \text{FactorRealizedAt}(F, s). \quad (48)$$

This stage-support requirement aligns global factor membership with stage-relative physical realization. It assigns neither numerical physical-system identity nor an identity range or private cosmic-stage succession to a physical factor.

Definition 4.1 (Stage-relative physical-factor population). For each admitted cosmic stage $s \in \mathcal{S}_{\text{C}}^{\text{tot}}$, define

$$\boxed{\mathfrak{F}_{\text{phys}}(s) := \{F \in \mathfrak{F}_{\text{phys}} \mid \text{FactorRealizedAt}(F, s)\}}. \quad (49)$$

Membership records physical-factor realization at s ; it does not by itself assert causal influence on any declared physical system.

Within the physical vocabulary used by V38/F18, every physically realized item admitted into the framework's system-factor classification is typed explicitly as either a physical-system identity or a physical factor. This is a framework typing rule, not a claim that present physics has exhausted every possible ontological category:

$$\text{ITOFPhysicallyTyped}(x) \implies [x \in \mathcal{U}_{\text{phys}} \vee x \in \mathfrak{F}_{\text{phys}}]. \quad (50)$$

The rule supplies no causal mechanism and does not erase domain-specific physical classifications. Define, in addition, the domain of factors that actually influence at least one realized system-stage pair by

$$\mathfrak{F}_{\text{phys}}^{\text{inf}} := \left\{ F \in \mathfrak{F}_{\text{phys}} \mid \exists A \exists s \in \mathcal{S}_{\text{C}}^{\text{tot}} \text{ InfluencingPhysicalFactor}(F; A, s) \right\}. \quad (51)$$

Membership in $\mathfrak{F}_{\text{phys}}$ states physical realization as a factor; membership in $\mathfrak{F}_{\text{phys}}^{\text{inf}}$ additionally states actual influence on at least one realized system–stage pair.

An *influencing physical system* B is a distinct physical system outside the declared boundary of A whose actual physical influence contributes to the physical change realized in A at s . It remains a physical system with its own identity range and physical history:

$$\begin{aligned} \text{InfluencingPhysicalSystem}(B; A, s) \implies \\ B \in \mathcal{U}_{\text{phys}} \wedge A \in \mathcal{U}_{\text{phys}} \wedge B \neq A \wedge s \in I_B \wedge s \in I_A. \end{aligned} \quad (52)$$

Thus a stage-relative influence claim presupposes identity-stage realization of both the influencing system and the influenced system at that same admitted stage. Influencing physical factors and influencing physical systems are therefore two physically distinct source types of external physical influence. Their common causal role is influence on A ; that role does not change the physical type of the source.

Simple and composite systems are both admitted. Qualification of a simple system does not require a constituent decomposition. For a composite system, qualification at the composite level requires physically warranted interconnection and coherence among its constituent organization:

$$\begin{aligned} \text{CompositePhysicalSystem}_{\Omega}(B) \implies \exists \mathcal{C}_B \Big[\text{ConstituentOrganization}(\mathcal{C}_B, B) \\ \wedge \text{PhysicalInterconnection}_{\Omega}(\mathcal{C}_B; B) \\ \wedge \text{PhysicalCoherence}_{\Omega}(\mathcal{C}_B; B) \Big]. \end{aligned} \quad (53)$$

Interconnection is not mere proximity, and coherence is not mere co-location or set membership. The physically appropriate criterion may be structural, dynamical, organizational, or otherwise domain-specific; it need not assign a teleological function to the system.

Define the governing physical-system totality independently of any application scheme:

$$\boxed{\mathcal{U}_{\text{phys}} := \left\{ A \mid \text{PhysicalSystem}(A) \wedge \exists s \in \mathcal{S}_{\text{C}}^{\text{tot}} \text{ExistsAs}(A, s) \right\}.} \quad (54)$$

V38/F18 does not define a closed, privileged catalogue of physical factors. The detailed cross-domain taxonomy of external physical factors, external influencing physical systems, internal physical contributors, descriptor-to-source discipline, and their qualitative causal composition is given in Section 8. The present ontology section therefore does not repeat that catalogue. It fixes only the system–factor type boundary and the rule that the same physical contribution is not counted twice under different causal roles.

V38/F18 uses $\mathcal{U}_{\text{C}}^{\text{phys}}$ for the physical universe understood as the physical totality itself rather than as an independent receptacle containing physical entities. Its constitutive notation is

$$\boxed{\mathcal{U}_{\text{C}}^{\text{phys}} := \mathcal{U}_{\text{phys}} \sqcup_{\text{ont}} \mathfrak{F}_{\text{phys}}.} \quad (55)$$

Here $\sqcup_{\text{ont}}$ denotes a typed ontological totality: it does not mean arithmetic addition, spatial union, or placement of systems and factors inside a further physical container. The physical universe is therefore the total physical actuality constituted by qualified physical-system identities together with physically realized physical factors. The word *universe* adds no third receptacle around those constituents. The totality does not acquire one numerical system identity, one

causal agency, or one physical history replacing the many histories of its constituent systems. Influencing physical systems retain systemhood; physical factors retain factor typing; and neither causal role converts one type into the other. Time is not an additional constituent of this totality and the common cosmic stage is not a container in which the totality is placed. Accordingly,

$$\mathfrak{U}_C^{\text{phys}} \not\equiv_{\text{type}} \text{PhysicalContainer}, \quad \mathfrak{U}_C^{\text{phys}} \not\equiv_{\text{type}} \text{PhysicalSystemIdentity}. \quad (56)$$

Because $\mathcal{U}_{\text{phys}}$ is a domain of numerical physical-system identities, the second type boundary gives

$$\mathfrak{U}_C^{\text{phys}} \notin \mathcal{U}_{\text{phys}}. \quad (57)$$

This does not deny that physical systems can causally affect one another or that physical factors can contribute to system change. It only prevents the physical totality itself from being silently retyped as one system identity or as a causal container. CMA continues to quantify over physical-system identities and their common cosmic stages; inclusion of physical factors in the cosmic physical totality does not give those factors system identities or private identity ranges.

For an application that fixes a physically warranted qualification scheme $\mathfrak{Q}$, define the application-selected subdomain

$$\mathcal{U}_{\text{phys}}^{[\mathfrak{Q}]} := \{A \in \mathcal{U}_{\text{phys}} \mid \text{PhysicalSystem}_{\mathfrak{Q}}(A)\}. \quad (58)$$

Thus $\mathfrak{Q}$ controls warranted identification and counting in a declared application; it does not determine whether the underlying physical system or the cosmic stage exists. In foundational statements, “qualified physical system” means an objectively admitted member of $\mathcal{U}_{\text{phys}}$; the indexed notation $\text{PhysicalSystem}_{\mathfrak{Q}}$ is reserved for application-level class, boundary, granularity, and attribution criteria. The framework does not require one unique decomposition of all physical reality for every scientific purpose.

For each $A \in \mathcal{U}_{\text{phys}}$, define its realized numerical-identity range

$$I_A := \{s \in \mathcal{S}_C^{\text{tot}} \mid \text{ExistsAs}(A, s)\}. \quad (59)$$

Then $I_A \neq \emptyset$. It is a restriction of the one cosmic-stage succession, not a private time or private change-stage sequence.

At stage s , define the complete then-realized qualified population

$$\mathcal{S}_{\text{phys}}(s) := \{A \in \mathcal{U}_{\text{phys}} \mid s \in I_A\}. \quad (60)$$

Definition 4.2 (Stage-relative cosmic physical totality). For each admitted cosmic stage $s \in \mathcal{S}_C^{\text{tot}}$, define

$$\mathfrak{U}_C^{\text{phys}}(s) := \mathcal{S}_{\text{phys}}(s) \sqcup_{\text{ont}} \mathfrak{F}_{\text{phys}}(s). \quad (61)$$

The typed union records the physical-system identities and non-system physical factors realized at s . It is not a container, does not make a factor a system, and does not enlarge CMA from physical-system co-presence into a claim that factors possess system identity ranges.

Membership in $\mathcal{S}_{\text{phys}}(s)$ is objective numerical-identity realization in the governing ontic physical-system domain, not observer knowledge, application-level classification, or successful detection:

$$\mathcal{S}_{\text{phys}}(s) \neq \text{SystemsKnownToObserverAt}(s), \quad (62)$$

$$A \in \mathcal{S}_{\text{phys}}(s) \not\Rightarrow \text{Detected}(A; s). \quad (63)$$

4.2 Derived Cosmic Change-Stage Population Principle

Retain the historical acronym CSPP for the stage-population condition

$$\boxed{\text{CSPP} \iff \forall s \in \mathcal{S}_{\text{C}}^{\text{tot}}, \quad \mathcal{S}_{\text{phys}}(s) \neq \emptyset.} \quad (64)$$

Under the governing stage semantics this is no longer an independent postulate. From temporal admissibility, every admitted stage is a realized physical-change stage, so some admitted physical system is realized and changing there; hence

$$\text{TemporalExtensionAdmissible}_{\text{C}}(\mathcal{S}_{\text{C}}^{\text{tot}}, \prec_{\text{C}}) \implies \text{CSPP}. \quad (65)$$

CSPP remains useful as a named population corollary, but it must not be counted as an additional independent foundation-level burden.

4.3 Identity Incidence and Objective Common-Stage Co-Presence

The relation $\text{ExistsAs}(A, s)$ records numerical identity–stage incidence within the single formal domain of cosmic stages. Incidence fixes the identity-domain relation to member s of the formal cosmic-stage domain; it does not by itself assert the collective ontological relation of objective co-presence among the complete population at s . That additional collective claim is expressed by $\text{CosmicCoPresence}_{\text{C}}(\mathcal{S}_{\text{phys}}(s); s)$ and is adopted by CMA:

$$A \in \mathcal{S}_{\text{phys}}(s) \iff A \in \mathcal{U}_{\text{phys}} \wedge \text{ExistsAs}(A, s). \quad (66)$$

Every identity range satisfies $I_A \subseteq \mathcal{S}_{\text{C}}^{\text{tot}}$. This fixes the formal domain on which common-stage claims are stated but does not reduce objective co-presence to set membership.

For $P \subseteq \mathcal{U}_{\text{phys}}$ and $s \in \mathcal{S}_{\text{C}}^{\text{tot}}$, $\text{CosmicCoPresence}_{\text{C}}(P; s)$ denotes objective co-realization of the members of P at one and the same cosmic stage s . Its typed signature is

$$\boxed{\text{CosmicCoPresence}_{\text{C}} \subseteq \mathcal{P}(\mathcal{U}_{\text{phys}}) \times \mathcal{S}_{\text{C}}.} \quad (67)$$

The relation is meaning-fixed but not definitionally reducible to population membership, clock agreement, synchronization, signal access, or coordinate equality:

$$\text{CosmicCoPresence}_{\text{C}}(P; s) \not\equiv_{\text{def}} [P = \{A \in \mathcal{U}_{\text{phys}} \mid \text{ExistsAs}(A, s)\}]. \quad (68)$$

The population construction states which qualified identities are represented at s ; CMA separately asserts their objective common-stage co-presence.

4.4 Cosmic Moment Axiom

Axiom 4.3 (Cosmic Moment Axiom (CMA)). At every admitted cosmic stage s , the complete qualified physical-system population realized at that stage is objectively co-present at that same one common cosmic stage. No system has a private ITOF cosmic-stage succession later synchronized with another. Formally,

$$\boxed{\text{CMA} \iff \forall s \in \mathcal{S}_{\text{C}}^{\text{tot}}, \quad \text{CosmicCoPresence}_{\text{C}}(\mathcal{S}_{\text{phys}}(s); s).} \quad (69)$$

CMA asserts unity of the cosmic stage, not equality of physical state, physical change, magnitude, rate, cause, location, clock reading, signal condition, or physical history. It does not state that every realized system changes; that independent physical commitment is UCC.

$$\text{CMA} \not\Rightarrow \forall s \in \mathcal{S}_C^{\text{tot}} \forall A, B \in \mathcal{S}_{\text{phys}}(s), X_A(s) = X_B(s), \quad (70)$$

$$\text{CMA} \not\Rightarrow \forall s \in \mathcal{S}_C^{\text{tot}} \forall A, B \in \mathcal{S}_{\text{phys}}(s), \mathbf{x}_A^{(F)}[s] = \mathbf{x}_B^{(F)}[s], \quad (71)$$

$$\text{CMA} \not\Rightarrow \text{UniversalPairwisePhysicalInteraction}, \quad (72)$$

$$\text{CMA} \not\Rightarrow \text{UniversalInstantaneousSignalAccessibility}, \quad (73)$$

$$\text{CMA} \not\Rightarrow \text{UCC}. \quad (74)$$

4.5 CMA is non-causal

CMA supplies no physical mechanism. Neither objective co-presence nor the common cosmic stage causes system-specific physical change:

$$\text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s) \not\Rightarrow \text{StageCausesChange}(s). \quad (75)$$

Time, the cosmic stage, and common-stage co-presence are not physical causal-source classes. Physical causation is governed separately by CRP.

5. Universal Change Continuity

5.1 Actual-change subset and change-content typing

For $A \in \mathcal{U}_{\text{phys}}$, define

$$I_A^\Delta := \{s \in I_A \mid \text{PhysReal}_A^+(s)\}. \quad (76)$$

Let Ξ_A be the system-specific physical-change-content type appropriate to A , and define

$$\boxed{\Delta_A^{\text{phys}} : I_A^\Delta \longrightarrow \Xi_A.} \quad (77)$$

The restricted domain keeps change content well typed in formal countermodels in which physical change is denied at selected identity-stage pairs.

5.2 Universal Change Continuity Postulate

Postulate 5.1 (Universal Change Continuity (UCC)). For every qualified physical system A , actual system-specific physical change continues throughout its complete realized identity range I_A without an admitted change-null member:

$$\boxed{\text{UCC} \iff \forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A, \quad \text{PhysReal}_A^+(s).} \quad (78)$$

UCC is an independent foundational physical postulate. It does not follow from CMA, strict ordering, stage membership, or temporal admissibility. It applies whether the system-specific change is observed, unobserved, or below the relevant detection threshold. Its continuity is non-metric and does not imply differentiability, equal change magnitude, a universal rate, one universal mechanism, unlimited identity duration, or an infinite cosmic future.

Ending of identity A ends the UCC requirement only beyond I_A ; it does not suspend UCC for other realized systems and does not require successor production.

The stagewise form follows from the definition of $\mathcal{S}_{\text{phys}}(s)$:

$$\text{UCC} \iff \forall s \in \mathcal{S}_C^{\text{tot}} \forall A \in \mathcal{S}_{\text{phys}}(s), \quad \text{PhysReal}_A^+(s). \quad (79)$$

This is a quantifier reformulation of UCC, not CMA. CMA and UCC remain logically distinct because CMA concerns objective common-stage co-presence whereas UCC concerns system-specific physical-change actuality.

Accordingly,

$$\text{UCC} \implies \forall A \in \mathcal{U}_{\text{phys}}, \quad I_A^\Delta = I_A. \quad (80)$$

5.3 Physical actuality criterion and genuine contrary

The predicate $\text{PhysReal}_A^+(s)$ asserts actual system-specific physical change in A at s . It is not definitionally a finite difference between two admitted stages, does not require an immediate predecessor or successor in I_A , and supplies no universal scalar magnitude or rate. Its scientific attribution is not warranted by stage membership, terminology, or detectability. In every concrete application, the physical-system boundary and organizational granularity G , together with an applicable physical theory or independently warranted physical model M , must be declared. Attribution of $\text{PhysReal}_A^+(s)$ requires M , at that declared granularity, to warrant at least one physically constitutive process, transition, formation, reconfiguration, constituent exchange, interaction-mediated modification, field-coupled change, structural change, or other physically admissible realization of change in A at s . The listed forms are illustrative rather than exhaustive and remain typed by the applicable physics.

Where M represents change through comparison of state variables or physical relations across suitable realizations, a warranted difference in at least one physically constitutive component can serve as evidence of change. Such a comparison is not the universal definition of change in V38/F18. In particular, formation at the least member f_A can realize physical change through the formation process itself even though there is no earlier member of the same numerical identity range; an ending transformation is treated analogously. Thus the criterion does not smuggle a predecessor requirement into every system stage.

The model and granularity indices discipline warrant; they do not relativize the foundational predicate into a model-created fact and they are not additional arguments of $\text{PhysReal}_A^+(s)$. Equality of a selected observable, a stationary coarse-grained description, equilibrium terminology, criterion-relative stability, or finite non-detection is insufficient by itself to establish complete physical non-change. Conversely, if the applicable physics at the declared system boundary and granularity positively warrants that no physically constitutive change admissible to the claim is realized in A at s , that warranted case is the genuine physical contrary targeted by $\text{NC}_A^{\text{phys}}(s)$ and is a direct countercondition to UCC. It does not by itself negate CMA, whose direct contrary is failure of objective common-stage co-presence for the complete then-realized qualified population.

Define complete physical non-change by

$$\text{NC}_A^{\text{phys}}(s) \iff \neg \text{PhysReal}_A^+(s). \quad (81)$$

Then

$$\text{UCC} \iff \forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A, \quad \neg \text{NC}_A^{\text{phys}}(s). \quad (82)$$

The logical contrary in Eq. (81) therefore has a demanding but non-vacuous physical warrant condition: it must be supported by the applicable physics at the declared system boundary and granularity, not inferred from an unchanging selected record. Criterion-relative stability, operational waiting, or non-detection is not complete physical non-change. UCC is identity-bounded: if a numerical identity A ends at its terminal identity stage e_A , UCC places no condition on A beyond e_A . The ending of A does not cancel UCC for other qualified identities that remain realized or for genuinely new identities that are physically formed.

5.4 No universal change magnitude, rate, or substance

UCC universalizes physical-change actuality, not change content. Therefore

$$\text{UCC} \not\Rightarrow \text{UniversalScalarMagnitudeOfPhysicalChange}, \quad (83)$$

$$\text{UCC} \not\Rightarrow \text{UniversalScalarRateOfPhysicalChange}, \quad (84)$$

$$\text{UCC} \not\Rightarrow \text{OneUniversalChangeSubstance}. \quad (85)$$

A system-specific scalarization, where physically warranted, remains an application-level construction.

5.5 Criterion-relative stability and observation

A qualified system may satisfy a declared stability criterion while UCC remains true. Selected observables can be unchanged, unresolved, or below threshold even when physical change continues. For a declared protocol P and model M ,

$$\text{NoResolvedDifference}_{P,M}(A; r, s) \not\Rightarrow \text{NC}_A^{\text{phys}}(s). \quad (86)$$

The phrase *criterion-relative stability* is therefore reserved for a system-level observational or physical criterion. It is not the meaning of the fixed cosmic temporal order.

5.6 Exact quantum stationary states and the UCC burden

A stationary quantum representation must be handled without converting formal parameter dependence into physical change. For a time-independent Hamiltonian, let

$$\hat{H}|E\rangle = E|E\rangle, \quad |\psi(\tau)\rangle = e^{-iE\tau/\hbar}|E\rangle, \quad (87)$$

where τ is the evolution parameter of the declared quantum model and is not identified with T_{TOF} . The corresponding pure-state density operator is

$$\rho(\tau) = |\psi(\tau)\rangle\langle\psi(\tau)| = |E\rangle\langle E|, \quad (88)$$

so expectation values of time-independent observables are stationary in the standard energy-eigenstate case [30, 31].

V38/F18 therefore does not count the global phase $e^{-iE\tau/\hbar}$ by itself as $\text{PhysReal}_A^+(s)$. A global phase, a stationary wavefunction label, an unchanged selected expectation value, or a time-

independent density operator is not automatically an actual physical-change content. UCC instead requires an independently warranted physical change in the qualified physical system under the declared system boundary.

The converse restraint is equally important. A stationary state assignment in an idealized model does not by itself establish complete physical non-change of the full qualified system. The physical boundary may include fields, environmental couplings, internal degrees of freedom, or other physically warranted structure not represented by the selected stationary observable. Accordingly,

$$\text{StationaryQuantumRepresentation}_M(A) \not\Rightarrow \text{NC}_A^{\text{phys}}(s). \quad (89)$$

But if independently warranted physics and a sufficiently complete declared system model establish $\text{NC}_A^{\text{phys}}(s)$ for some qualified $A \in \mathcal{U}_{\text{phys}}$ and $s \in I_A$, that is a direct countercondition to UCC rather than something to be reclassified as hidden change:

$$\text{WarrantedCompletePhysicalNonChange}_M(A, s) \implies \text{NC}_A^{\text{phys}}(s) \implies \neg \text{UCC}. \quad (90)$$

Thus exact stationary-state cases are a genuine scientific burden for UCC: ITOF must either identify independently warranted actual physical change in the declared system or accept the warranted complete-nonchange case as falsifying that postulate. The framework does not use measurement non-resolution, a global phase, or interpretive terminology to evade this burden.

6. Common-Stage Change and Empirical Structure

6.1 Actual-change population

Define

$$\mathcal{B}_\Delta(s) := \{A \in \mathcal{S}_{\text{phys}}(s) \mid \text{PhysReal}_A^+(s)\}. \quad (91)$$

By definition,

$$\mathcal{B}_\Delta(s) \subseteq \mathcal{S}_{\text{phys}}(s). \quad (92)$$

Under the definitions of I_A , $\mathcal{S}_{\text{phys}}(s)$, and $\mathcal{B}_\Delta(s)$,

$$\text{UCC} \iff \forall s \in \mathcal{S}_C^{\text{tot}}, \quad \mathcal{B}_\Delta(s) = \mathcal{S}_{\text{phys}}(s). \quad (93)$$

6.2 No physically change-null admitted stage

Under the governing stage semantics, an admitted stage already denotes an objectively realized physical change. Therefore

$$\text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \implies \forall s \in \mathcal{S}_C^{\text{tot}}, \quad \mathcal{B}_\Delta(s) \neq \emptyset. \quad (94)$$

This is not a claim that a stage is a container that must be “filled”; it says that no stage symbol is admitted for a complete absence of physical change.

UCC strengthens this minimal non-nullness to complete then-realized physical system coverage when combined with temporal admissibility:

$$\text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \wedge \text{UCC} \implies \forall s \in \mathcal{S}_C^{\text{tot}}, \quad \mathcal{B}_\Delta(s) = \mathcal{S}_{\text{phys}}(s) \neq \emptyset. \quad (95)$$

Define

$$\text{GlobalChangeNull}_C(s) \iff \mathcal{B}_\Delta(s) = \emptyset. \quad (96)$$

Then

$$\text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \implies \forall s \in \mathcal{S}_C^{\text{tot}}, \quad \neg \text{GlobalChangeNull}_C(s). \quad (97)$$

The distinction is now exact: stage semantics supplies at least one actual change realization. The one-global-stage architecture supplies one common formal cosmic-stage domain. CMA supplies objective common-stage co-presence, while UCC supplies complete system-specific actual-change coverage across the then-realized qualified population.

6.3 Foundational Stage-to-Change Representation

Define the local full-theory common-stage change condition by

$$\boxed{\text{StageChangeBridge}_C(s) \iff [\text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s) \wedge \mathcal{B}_\Delta(s) = \mathcal{S}_{\text{phys}}(s)]}. \quad (98)$$

This is a defined conjunction of the local CMA content and the stagewise UCC content. It is not an axiom, causal law, synchronization rule, measurement bridge, or dynamics. Therefore,

$$\text{CMA} \wedge \text{UCC} \implies \forall s \in \mathcal{S}_C^{\text{tot}}, \quad \text{StageChangeBridge}_C(s). \quad (99)$$

The defined bridge introduces no additional foundational commitment.

6.4 Complete All-System Change Realization under UCC

Under temporal admissibility and UCC,

$$\text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \wedge \text{UCC} \implies \forall s \in \mathcal{S}_C^{\text{tot}}, \quad \mathcal{B}_\Delta(s) = \mathcal{S}_{\text{phys}}(s) \neq \emptyset. \quad (100)$$

CMA may be conjoined when the full common-stage interpretation is required, but complete all-system change coverage is the burden of UCC rather than CMA.

6.5 Common-stage system-change profile

Define

$$\mathfrak{D}_C(s) := \left(A \mapsto \Delta_A^{\text{phys}}(s) \right)_{A \in \mathcal{B}_\Delta(s)} \in \prod_{A \in \mathcal{B}_\Delta(s)} \Xi_A. \quad (101)$$

Under UCC,

$$\text{UCC} \implies \text{dom } \mathfrak{D}_C(s) = \mathcal{S}_{\text{phys}}(s). \quad (102)$$

The dependent product preserves heterogeneous system-specific change-content types and does not create a universal change codomain.

6.6 Foundational realization is not an empirical bridge

The defined proposition $\text{StageChangeBridge}_C(s)$ is not a model-input map, physical dynamics, model-output map, or measurement bridge. For a declared model M , application physics requires

independently specified structures such as

$$\mathcal{I}_M^{\text{phys}} \xrightarrow{\mathcal{B}_M^{\text{in}}} \mathcal{I}_M^{\text{model}} \xrightarrow{\text{Dyn}_M} \mathcal{O}_M^{\text{model}} \xrightarrow{\mathcal{B}_M^{\text{out}}} \mathcal{O}_M^{\text{phys}} \xrightarrow{\mathcal{B}_{P,M}^{\text{obs}}} \mathcal{R}_{P,M}. \quad (103)$$

Neither the temporal definition, CMA, nor UCC supplies these maps or dynamics.

6.7 Illustrative application-level measurement bridge

A concrete bridge can be specified without converting the cosmic-stage order into an observable coordinate. Let an independently warranted physical model M produce a scalar physical prediction $q_M \in \mathcal{O}_M^{\text{phys}}$. For a declared measurement protocol P , let $K_{P,M}(\text{d}y \mid q)$ be a calibrated conditional record kernel on the record space $\mathcal{R}_{P,M}$. The corresponding stochastic measurement bridge is typed as

$$\mathcal{B}_{P,M}^{\text{obs}} : \mathcal{O}_M^{\text{phys}} \longrightarrow \text{Prob}(\mathcal{R}_{P,M}), \quad q \longmapsto K_{P,M}(\cdot \mid q), \quad (104)$$

where $\text{Prob}(\mathcal{R}_{P,M})$ denotes the admissible probability measures on the declared record space. A deterministic bridge is included as the special case in which the kernel is a Dirac measure. The predicted observable object is therefore the record law

$$\mathbf{Y}_{P,M} \sim K_{P,M}(\text{d}y \mid q_M). \quad (105)$$

Calibration parameters, acquisition response, resolution, and stochastic noise belong to the independently declared kernel $K_{P,M}$; they are not supplied by $\mathcal{S}_C^{\text{tot}}$, $\prec_C$, CMA, or UCC. This construction specifies no direct stage-to-record map: stage membership can index the physical realization to which the independently specified model applies, but the physical response law and the measurement bridge remain additional application structure.

For the mass-defect clock branch developed later, one may take $q_M = \Delta\omega/\omega_0$, with the physical response law supplying q_M and the declared protocol kernel supplying the record distribution. This is an example of the typed bridge architecture, not an additional foundational postulate and not an ITOF-specific modification of atomic-clock dynamics.

Worked fractional-frequency record kernel

The generic kernel above can be instantiated without assigning temporal identity to the measured quantity. For a fractional-frequency application, let

$$q_M := \frac{\Delta\omega}{\omega_0}, \quad (106)$$

where the physical model supplies the predicted fractional shift. If the declared protocol P has an independently calibrated additive record offset b_P and standard deviation $\sigma_P > 0$, one admissible illustrative record kernel is

$$K_{P,M}(\text{d}y \mid q_M) = \frac{1}{\sqrt{2\pi}\sigma_P} \exp\left[-\frac{(y - (q_M + b_P))^2}{2\sigma_P^2}\right] \text{d}y. \quad (107)$$

Equivalently,

$$\mathbf{Y}_{P,M} = q_M + b_P + \varepsilon_P, \quad \varepsilon_P \sim \mathcal{N}(0, \sigma_P^2). \quad (108)$$

This example demonstrates only the prediction-to-record layer. The values and uncertainties of b_P and σ_P must come from the declared calibration and acquisition model; V38/F18 supplies neither. A non-Gaussian or correlated kernel must replace this form where the experimental record process requires it. Neither q_M nor $\mathbf{Y}_{P,M}$ is thereby identified with T_{TOF} , with a member of $\mathcal{S}_C^{\text{tot}}$, or with an exact common cosmic stage. The later atomic-clock application supplies the relevant physical response law; the present construction only makes the measurement-bridge typing explicit.

6.8 Conditional discriminating application template

If a future independently warranted physical extension supplies a specific interaction

$$\hat{H}_I = \hat{H}_{\text{base}} + \lambda_X \hat{O}_X, \quad \hat{H}_R = \hat{H}_{\text{base}}, \quad (109)$$

then a candidate observable separation may take the form

$$\Delta y_{I:R}^{P^*, D^*} = \lambda_X K_X^{P^*, D^*}. \quad (110)$$

These are conditional application equations, not consequences of the temporal definition, CMA, or UCC. If the two branches have the same complete physical-to-observable specification, no ontology-only prediction separation follows.

7. System-Specific States at Common Stages

7.1 System-specific physical state spaces

For each $A \in \mathcal{U}_{\text{phys}}$, let

$$\Omega_A \quad (111)$$

denote a declared physical state space adequate to the physical description of that system under the application or theoretical context being considered.

Define:

$$X_A : I_A \longrightarrow \Omega_A. \quad (112)$$

For every $s \in I_A$,

$$X_A(s) \quad (113)$$

denotes the physical state of A realized at common cosmic change stage s .

The state and the common cosmic change stage remain type-distinct:

$$s \not\equiv_{\text{type}} X_A(s). \quad (114)$$

Likewise, under UCC,

$$s \not\equiv_{\text{type}} \Delta_A^{\text{phys}}(s). \quad (115)$$

The common cosmic change stage is universal. The physical state and the physical-change content are system-specific.

7.2 No universal physical-state codomain

Common-stage realization does not require all physical systems to be described through one state space.

For distinct systems:

$$A, B \in \mathcal{S}_{\text{phys}}(s) \wedge A \neq B \not\Rightarrow \Omega_A = \Omega_B. \quad (116)$$

Accordingly, V38/F18 introduces no universal physical-state space Ω_{univ} satisfying

$$\text{CommonStageRealization} \not\Rightarrow \exists \Omega_{\text{univ}} \forall A \in \mathcal{U}_{\text{phys}}, \quad \Omega_A = \Omega_{\text{univ}}. \quad (117)$$

as a foundational requirement.

A common mathematical representation may be constructed in a particular physical model where scientifically justified. Such a representation remains an application-level construction and does not identify the physical states of distinct systems.

7.3 Common-stage physical-state profile

At $s \in \mathcal{S}_C^{\text{tot}}$, every $A \in \mathcal{S}_{\text{phys}}(s)$ satisfies $s \in I_A$. Therefore $X_A(s)$ is well typed for the complete then-realized qualified population.

Definition 7.1 (Common-Stage Physical-State Profile). Define:

$$\mathfrak{X}_C(s) := (A \mapsto X_A(s))_{A \in \mathcal{S}_{\text{phys}}(s)} \in \prod_{A \in \mathcal{S}_{\text{phys}}(s)} \Omega_A. \quad (118)$$

The dependent product is essential. It preserves the possibility that different physical systems require different physical state spaces.

The profile does not identify the system-specific states:

$$\mathfrak{X}_C(s) \not\equiv_{\text{def}} \text{OneUniversalPhysicalState}(s). \quad (119)$$

Nor does the existence of the profile imply:

$$\text{Defined}(\mathfrak{X}_C(s)) \not\Rightarrow \forall A, B \in \mathcal{S}_{\text{phys}}(s), \quad X_A(s) = X_B(s). \quad (120)$$

The profile is a formal population-indexed representation of physically distinct system states realized at one common cosmic change stage.

7.4 Common Stage Is Not a Totality State

Remark 7.2 (Stage/profile type boundary). The common cosmic change stage s , the temporal referent T_{ITOF} , and the stage-relative physical-state profile $\mathfrak{X}_C(s)$ remain type-distinct. The first is a common cosmic change stage, the second is the governing temporal ordered pair, and the third is a formal population-indexed representation of physical states realized by the stage-relative population. No definition in this section identifies either s or T_{ITOF} with $\mathfrak{X}_C(s)$.

8. Physical Causes and Contributors of Change

8.1 Causation remains physical and system-specific

The UCC states that each qualified physical system realizes its own physical change. It does not make time, cosmic ordering, or common-stage unity the cause of that change.

The causal architecture of V38/F18 is organized around three physically typed source classes: internal physical contributors of the changing system, external influencing physical systems, and external influencing non-system physical factors. This section consolidates their definitions, families, interactions, and system-specific effects in one place.

For every actual-change pair:

$$A \in \mathcal{U}_{\text{phys}}, \quad s \in I_A^\Delta, \quad (121)$$

the causal account belongs to the physically realized system and its physically admissible contributors.

The following are not causal-source classes:

$$\left\{ \begin{array}{l} T_{\text{ITOF}}, \mathcal{E}_C, \mathcal{U}_C^{\text{phys}}, s, \prec_C, \text{CSPP}, \text{CMA}, \text{UCC}, \\ \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C), \text{StageChangeBridge}_C, \text{CRP} \end{array} \right\} \quad (122)$$

$$\cap \text{PhysicalCausalSourceClass} = \emptyset.$$

This expression states a type boundary. It does not assert that the listed formal or foundational items are members of one ordinary set-valued physical domain. In particular, $\mathcal{U}_C^{\text{phys}}$ is not itself a causal-source class or a single causal agent; its constituent physical systems and influencing physical factors may nevertheless be actual causal contributors under the causal roles defined below.

8.2 Three causal-source classes

For physical system A at s , V38/F18 separates the actual physical causal basis into internal physical contribution and external physical influence. External physical influence may be produced by an influencing physical factor or by an influencing physical system. These two source types perform the same causal role relative to A : each can produce physical influence that contributes to A 's change, while retaining its own physical type.

Let

$$\mathcal{C}_A^{\text{int}}(s) \quad (123)$$

denote the actual internal physical contributors to the change realized in A .

Define the influencing physical-system and physical-factor source sets by

$$\mathcal{C}_A^{\text{infl-sys}}(s) := \{B \in \mathcal{U}_{\text{phys}} \mid \text{InfluencingPhysicalSystem}(B; A, s)\}. \quad (124)$$

$$\mathcal{C}_A^{\text{infl-factor}}(s) := \{F \in \mathfrak{F}_{\text{phys}} \mid \text{InfluencingPhysicalFactor}(F; A, s)\}. \quad (125)$$

Thus $\mathcal{C}_A^{\text{infl-sys}}(s) \subseteq \mathcal{U}_{\text{phys}}$ and $\mathcal{C}_A^{\text{infl-factor}}(s) \subseteq \mathfrak{F}_{\text{phys}}^{\text{inf}}$. System sources remain physical systems; factor sources remain physical factors with their domain-specific physical typing.

Collect the external sources of physical influence on A as

$$\mathcal{E}_A^{\text{ext}}(s) := \mathcal{C}_A^{\text{infl-sys}}(s) \cup \mathcal{C}_A^{\text{infl-factor}}(s). \quad (126)$$

Every member of $\mathcal{E}_A^{\text{ext}}(s)$ contributes external physical influence to A . A system source remains a physical system; a factor source remains a physical factor.

The causal profile is therefore

$$\mathfrak{C}_A(s) := \left(\mathcal{C}_A^{\text{int}}(s), \mathcal{E}_A^{\text{ext}}(s) \right). \quad (127)$$

For one declared system boundary, internal contribution and external influence are distinct roles, and the two external source types remain type-distinct:

$$\mathcal{C}_A^{\text{int}}(s) \cap \mathcal{E}_A^{\text{ext}}(s) = \emptyset, \quad \mathcal{C}_A^{\text{infl-sys}}(s) \cap \mathcal{C}_A^{\text{infl-factor}}(s) = \emptyset. \quad (128)$$

The complete actual physical causal set is

$$\mathcal{C}_A^{\text{act}}(s) := \mathcal{C}_A^{\text{int}}(s) \cup \mathcal{E}_A^{\text{ext}}(s). \quad (129)$$

This structure introduces no additional causal-source type. It distinguishes where the physical contribution comes from while stating the causal relation directly: actual internal physical contribution and/or actual external physical influence contributes to the system-specific change.

The classification into internal contributors, external influencing systems, and external influencing non-system factors is exhaustive at the ITOF causal-typing level. It does not assert that every member of any broad physical family is causally active in every application; actual membership requires warranted physical contribution to the particular change.

8.3 Illustrative physical-factor families and effects

ITOF imposes no closed catalogue of physical factors. The following list is illustrative and non-exhaustive. Each entry identifies a physical-factor family and effects that may occur when a factor in that family is physically realized and actually influences the system. An influencing physical system may generate, carry, or mediate such physical influence while remaining a physical system. The list does not create additional causal-source types or universal response laws.

- (i) **Mechanical, contact, and kinematic contributions.** Physically realized loads, pressure conditions, stress or strain, contact, impact, shock, vibration, acceleration, rotation, and momentum-transfer processes may alter motion, configuration, deformation, oscillation, structural integrity, transport, or failure behaviour according to the system's mechanics and constitutive law.
- (ii) **Thermal and thermodynamic contributions.** Physically realized thermal conditions, temperature differences or gradients, heat-transfer processes, and phase conditions may alter internal-energy distribution, expansion or contraction, phase, transport coefficients, reaction rates, material properties, or other system-specific thermodynamic responses.
- (iii) **Electromagnetic contributions.** Physically realized electric or magnetic fields and gradients, charge and current distributions, and electromagnetic couplings may produce forces, polarization, excitation, ionization, current redistribution, heating, transition response, or other field-dependent changes permitted by the physical model.

- (iv) **Gravitational contributions.** Physically realized gravitational relations, field or potential gradients, and tidal conditions may contribute to acceleration, trajectory change, binding, stress, energy-state response, or other gravity-dependent behaviour permitted by the physical model.
- (v) **Radiative and particle-transfer contributions.** Photon, particle, material, momentum, or energy transfer and exposure may contribute to excitation, ionization, heating or cooling, momentum exchange, detector response, photochemical change, material modification, or biological effects where the applicable physics warrants them.
- (vi) **Nuclear, subatomic, and reaction-channel contributions.** Physically realized nuclear interactions, incident particle channels, capture, scattering, transmutation, externally induced decay or excitation pathways, and related subatomic processes may contribute where the applicable nuclear or particle physics establishes an actual influence. A decay constant, cross section, or branching ratio is a descriptor or model quantity; causal attribution belongs to the realized physical process and interaction.
- (vii) **Chemical and material contributions.** Composition, concentration or chemical-potential gradients, chemical interaction, material exchange, solvent or medium conditions, adsorption, dissolution, corrosion, and related processes may alter bonding, composition, phase, diffusion, structure, or reaction pathways.
- (viii) **Fluid, plasma, and transport contributions.** Physically realized fluid conditions, pressure and flow fields, shear, material transport, plasma conditions, and associated couplings may contribute to drag, compression, mixing, heat or mass transfer, erosion, transport, or other continuum or plasma responses allowed by the governing physics.
- (ix) **Wave, oscillatory, and resonant contributions.** Mechanical, acoustic, electromagnetic, or other physically instantiated wave and oscillatory processes may transfer energy or momentum, excite modes, produce resonance, fatigue, transition response, interference effects, or other coupling-dependent changes. A numerical frequency by itself is only a descriptor; causal attribution belongs to the realized oscillatory process or interaction carrying it.
- (x) **Boundary, interface, confinement, and structural contributions.** Physically realized boundaries, interfaces, confining boundaries or support relations, lattice or confinement conditions, trapping arrangements, and structural constraints may alter permitted modes, stress distribution, transport, interaction strength, transition conditions, or stability. Geometric or boundary parameters are not causes merely because they occur in an equation; the relevant physical realization must be identified.
- (xi) **Fluctuation, collision, disturbance, and noise contributions.** Physically realized collisions, perturbations, fluctuations, disturbances, or noise may contribute to diffusion, broadening, stochastic transitions, heating, decoherence, loss of stability, or other model-specific effects. Labels such as “vacuum fluctuation” or “noise” do not settle ontic or causal typing without the physical model and declared system boundary.
- (xii) **Biological, environmental, and complex-system influences.** Nutrient or material availability, pathogens, tissue or fluid conditions, regulatory couplings, surrounding instruments, atmosphere, direct exposure, and other environmental circumstances can matter only through their physically realized constituents, processes, pathways, boundaries, or influencing systems. The word “environment” is a descriptive aggregation, not an additional causal-source type.

The list does not restrict what physical factors may exist. An unlisted factor is admissible when

the applicable physics establishes its physical realization and actual influence. A numerical property or model parameter does not enter $\mathcal{C}_A^{\text{act}}(s)$ by itself; causal attribution belongs to the physically realized source and influence to which that description applies.

8.4 Descriptor-to-source discipline

Terms such as temperature, frequency, velocity, pressure, intensity, density, or field strength often denote measured or modelled properties rather than separate causal entities. Their causal use in ITOF is therefore tied to the physically realized condition or process that the descriptor characterizes. For example:

- temperature is causally relevant through a realized thermal condition, gradient, heat-transfer process, phase condition, or temperature-dependent physical interaction;
- frequency is causally relevant through a physically realized oscillatory, wave, radiative, resonant, or driven process characterized by that frequency;
- velocity or motion is causally relevant through the realized kinematic state, momentum transfer, collision, transport, inertial relation, or other motion-dependent physical interaction specified by the applicable model.

This discipline preserves the distinction between physically realized causal conditions and their numerical descriptors without reifying a descriptor into an independent causal source.

8.5 External influencing physical systems

External physical influence is not restricted to non-system factors. A numerically and physically distinct system B may contribute to the change realized in A while remaining a physical system with its own identity, state, change, causal profile, and physical history. The source relation is represented by $B \in \mathcal{C}_A^{\text{infl-sys}}(s)$; it does not convert B into a physical factor.

At the level of causal families, external influencing physical systems may include, where independently warranted by the applicable physics:

- (i) **Contacting, colliding, loading, or constraining systems**, including bodies, supports, tools, boundaries realized by another system, impactors, and mechanically coupled assemblies.
- (ii) **Gravitationally interacting systems**, including physical systems whose mass–energy distribution contributes gravitationally to the state or motion of A under the adopted gravitational model.
- (iii) **Electromagnetic source systems**, including charged bodies, current-bearing systems, electrodes, magnets, resonators, antennas, cavities, and other systems producing or shaping physically realized electromagnetic interaction.
- (iv) **Radiative or particle-emitting systems**, including sources whose photons, particles, or other physically transported emissions interact with A .
- (v) **Material reservoirs, fluids, plasmas, or surrounding media that satisfy the physical-system criterion**, where exchange, flow, pressure, shear, transport, reaction, or other interaction with A is physically established.
- (vi) **Control, preparation, interrogation, and measurement systems**, including apparatus whose fields, pulses, contacts, feedback actions, sampling, or other physically realized operations contribute to the state or change of A . The resulting record remains distinct

from the causal interaction that produced it.

- (vii) **Chemical, biological, or complex interacting systems**, where an independently identified system contributes through contact, exchange, regulation, signaling, metabolism, reaction, transport, or another physically warranted pathway.
- (viii) **Composite environmental or structural systems**, where the surrounding entity itself satisfies the system criterion and its interaction with A is physically resolved. A loose word such as “environment” does not by itself establish this status.

The list is a causal taxonomy, not a claim of universal all-to-all interaction. Cosmic co-presence under CMA does not imply that every physical system influences every other physical system, and causal influence need not be symmetric.

8.6 Internal physical contributors

Internal causal contribution includes more than externally visible activity. The internal physical basis of A may contain operative contributors arising from its realized constitution, organization, state, relations, retained conditions, and internal processes. Where independently warranted, the internal causal set $\mathcal{C}_A^{\text{int}}(s)$ may include contributions associated with:

- (i) **Material constitution and composition**, including constituent species, bonding structure, phase composition, concentration distributions, and other physically realized compositional organization.
- (ii) **Constituent arrangement and structural organization**, including geometry, topology, interfaces, defects, lattice organization, compartmentation, and other realized structural relations internal to the declared system.
- (iii) **Present internal state and distributions**, including population, occupation, density, charge, current, momentum, energy, polarization, or other physically warranted state distributions.
- (iv) **Stored or internally distributed energy and excitation**, including elastic, chemical, electromagnetic, thermal, rotational, vibrational, electronic, nuclear, or other model-warranted internal energy content.
- (v) **Internal stress, strain, pressure, deformation, and constitutive constraints**, where these are physically realized and operative in the change.
- (vi) **Internal field configurations and couplings**, where the fields or couplings belong to the declared physical description of the system and make an actual contribution rather than appearing only as mathematical parameters.
- (vii) **Internal motion and transport**, including constituent motion, rotation, vibration, oscillation, currents, flows, diffusion, and internal momentum or material transfer.
- (viii) **Microscopic interactions and transition dynamics**, including bonding, scattering, collisions, exchange, reaction, decay, excitation, relaxation, and other physically realized constituent-level processes.
- (ix) **Order, correlation, coherence, regulation, and feedback embodied physically in the system**, where such organization is part of the applicable physical model and is causally operative.
- (x) **Present physically embodied consequences of prior change**, including retained damage, stored strain, altered composition, remanent field configuration, memory state, or other currently realized condition. The past as such is not a cause; only the presently

embodied physical condition can enter the current causal profile.

A descriptive property or a numerical state variable is not promoted to an independent causal entity merely because it characterizes the internal system. Causal attribution belongs to the physically realized constitution, condition, interaction, process, or constraint to which the descriptor refers.

8.7 Qualitative causal composition and non-isolation of external influence

The three source classes are exhaustive at the framework-typing level: internal physical contributors, external influencing physical systems, and external influencing non-system physical factors. No fourth causal-source class is introduced. A particular change need not contain a member of every class, but its complete actual causal set must be nonempty under CRP.

The operative contributors may interact, combine, oppose, reinforce, attenuate, transform, gate, or condition one another in system-specific qualitative ways. ITOF therefore imposes no universal additive law in which a realized change is the arithmetic sum of independent factor effects. Where an application supplies an independently warranted causal-composition map, its generic role may be written schematically as

$$\Delta_A^{\text{phys}}(s) = \mathfrak{G}_A^{\text{phys}}\left(X_A(s); \mathcal{C}_A^{\text{int}}(s), \mathcal{C}_A^{\text{infl-sys}}(s), \mathcal{C}_A^{\text{infl-factor}}(s)\right), \quad (130)$$

where $\mathfrak{G}_A^{\text{phys}}$ is application-specific and is not a new universal ITOF law. Linearity, superposition, independence, or simple additivity may be used only when the applicable physics independently warrants them.

In particular, an external factor does not determine the realized change in isolation from the receiving physical system. Even where only one external source is identified, the consequence depends on the realized state, constitution, organization, coupling, boundary conditions, susceptibility, and other physically relevant features of A . Whether a particular element of that internal basis is entered explicitly in $\mathcal{C}_A^{\text{int}}(s)$ depends on the warranted causal model; the external source is never converted into a complete system-independent effect law merely by being named.

Thus a common external contributor can produce qualitatively different changes in distinct physical systems:

$$\begin{aligned} c \in \mathcal{E}_A^{\text{ext}}(s) \cap \mathcal{E}_B^{\text{ext}}(s), \quad A \neq B \\ \not\Rightarrow \Delta_A^{\text{phys}}(s) \equiv \Delta_B^{\text{phys}}(s). \end{aligned} \quad (131)$$

The difference may arise from physical-system identity, constitution, organization, present state, spatial relation, coupling strength, duration and intensity of exposure, internal coherence or stability, and presently embodied conditions produced by earlier change.

8.8 System-specific effect of external physical influence

Every member of $\mathcal{E}_A^{\text{ext}}(s)$ is an external source of physical influence on A . The source may be an influencing physical factor or an influencing physical system; its physical type does not change. The influence contributes to the physical change realized in A according to the applicable physics.

The resulting physical change is system-specific. Its physical form, magnitude, direction, or other measurable consequence is governed by the applicable dynamics, coupling, state, constitution, boundary conditions, and deterministic or stochastic structure of the receiving-system model.

The term *response* is only an application-level description of that result; it is not an intermediate causal entity or a universal response law. Quantitative comparison across different systems requires physically justified comparison variables or a declared comparison map.

Where a physical or functional criterion is declared, the consequence may be classified relative to that criterion. Let $\mathfrak{J}_A^{\text{imp}}$ denote such an application-level impact criterion. When the physical evidence is sufficient for classification,

$$\text{Impact}_{\mathfrak{J}_A^{\text{imp}}}(c; A, s) \in \{\text{Supportive, Adverse, Mixed, Neutral}\}. \quad (132)$$

The terms *beneficial* and *harmful* may be used only where the declared criterion gives them a physically or functionally precise meaning; otherwise *supportive* and *adverse* are preferred. An unresolved classification is an epistemic status, not a fifth physical impact type. The same contributor may be supportive for one physical system and adverse for another, or may change classification with state, intensity, duration, coupling, internal coherence, or criterion. UCC asserts the actuality of system-specific change; it assigns no universal positive or negative sign to that change.

8.9 Actual physical contribution

Let:

$$\text{PhysicallyContributes}(c; \Delta_A^{\text{phys}}(s)) \quad (133)$$

mean that physically admissible contributor c makes an actual physical contribution to the system-specific physical change designated by $\Delta_A^{\text{phys}}(s)$.

For an actual-change pair:

$$c \in \mathcal{C}_A^{\text{act}}(s) \iff \text{PhysicallyContributes}(c; \Delta_A^{\text{phys}}(s)). \quad (134)$$

Membership in the actual causal set asserts physical contribution only. It does not by itself make c the sole, sufficient, deterministic, universally earlier, or complete causal explanation; any such stronger status requires an independently established physical model.

8.10 Quantum and stochastic physical models

Causal typing is fixed by the declared system boundary, not by whether the application model is classical, deterministic, stochastic, or quantum. Internal physical contributors belong to $\mathcal{C}_A^{\text{int}}(s)$; external physical influence is sourced by $\mathcal{E}_A^{\text{ext}}(s)$, whose members are influencing physical factors or influencing physical systems. A mathematical state, operator, channel, probability law, or Hamiltonian is not thereby a physical causal source.

Entanglement, correlation, or nonfactorization alone does not establish *PhysicallyContributes*. Causal membership requires an actual physical contribution whose attribution is independently warranted under the declared application model and system boundary. Conversely, an intrinsically stochastic description does not conflict with CRP merely because it lacks a deterministic sufficient antecedent: CRP requires a nonempty set of actual physical contributors, not a hidden variable, unique antecedent, or deterministic mechanism.

Accordingly, CRP is neutral with respect to whether the admitted transition law is deterministic or intrinsically stochastic. It constrains the existence and typing of actual physical contributors,

not the uniqueness of an outcome conditioned on those contributors.

If a declared interpretation of a quantum process positively denies every actual physical contributor in $\mathcal{C}_A^{\text{int}}(s) \cup \mathcal{E}_A^{\text{ext}}(s)$ for a change that nevertheless satisfies $\text{PhysReal}_A^+(s)$, that application stands in direct tension with CRP. V38/F18 does not resolve such a tension by reclassifying probability, entanglement, the common cosmic stage, or time itself as a cause.

Interpretive scope and concrete examples.

V38/F18 does not classify a named quantum interpretation as globally “compatible” or “incompatible” merely from its label. The relevant application-level question is whether the declared quantum model supplies physically realized contributors that can be typed within $\mathcal{C}_A^{\text{int}}(s) \cup \mathcal{E}_A^{\text{ext}}(s)$ without reclassifying a state vector, probability law, operator, the common cosmic stage, or time itself as a physical cause.

A de Broglie–Bohm application provides one example of a quantum formulation with additional explicit physical variables and trajectories [32, 33]. Such variables may furnish candidates for application-level physical-contributor attribution where the declared system boundary and applicable dynamics warrant that attribution. This observation is not an endorsement of Bohmian mechanics, does not import its dynamics into ITOF, and does not establish compatibility with every ITOF commitment without a separate model-level analysis.

Environment-induced decoherence is treated differently. Decoherence is a physical open-system process or model structure, not by itself a complete interpretation of quantum mechanics, and it does not by itself settle the measurement problem [34]. Where an independently warranted system–environment interaction physically contributes to a realized change, that interaction may enter the appropriate causal set. Decoherence as a label, a reduced density matrix, or suppression of interference terms is not by itself a new causal-source type. Thus the limited claim of V38/F18 is interpretation-neutral: quantum applications are admissible when their physical ontology, dynamics, and causal attribution satisfy the declared ITOF typing conditions. ITOF neither derives quantum mechanics nor supplies a new quantum interpretation.

8.11 Causal Realization Principle

Postulate 8.1 (Causal Realization Principle (CRP)). Every actually realized system-specific physical change has a nonempty actual physical causal set:

$$\boxed{\text{CRP} \iff \forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A, \quad \text{PhysReal}_A^+(s) \implies \mathcal{C}_A^{\text{act}}(s) \neq \emptyset.} \quad (135)$$

The causal set is typed relative to the declared physical-system boundary. It contains actual internal physical contributors and/or external physical-influence sources. An external source may be an influencing physical factor or an influencing physical system; each retains its physical type. In a concrete application, attribution of the external influence must be warranted by the applicable physics. A descriptive property, model variable, or numerical parameter is not by itself a physical cause.

The realized effect remains system-specific and is realized according to the applicable physical dynamics and actual physical conditions of the receiving system. Time, the common cosmic stage, the earlier–later relation, a clock output, and the historical description of earlier change are not additional physical causes.

CRP is an independent foundational physical postulate; it is not derived from UCC, CMA, or the temporal definition. CRP and UCC have different functions:

$$\text{UCC} \implies \forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A, \quad \text{PhysReal}_A^+(s), \quad (136)$$

$$\text{CRP} \implies \forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A, \quad \text{PhysReal}_A^+(s) \implies \mathcal{C}_A^{\text{act}}(s) \neq \emptyset. \quad (137)$$

Thus:

$$\{\text{UCC}, \text{CRP}\} \vdash \forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A, \quad \text{PhysReal}_A^+(s) \wedge \mathcal{C}_A^{\text{act}}(s) \neq \emptyset. \quad (138)$$

CRP does not cause the physical changes whose causal realization it governs.

8.12 Unknown Cause Is Not Absent Causation

Epistemic incompleteness is not an additional causal category.

Thus:

$$\text{CauseNotIdentified}_{P,M}(A; s) \not\Rightarrow \mathcal{C}_A^{\text{act}}(s) = \emptyset. \quad (139)$$

An unresolved mechanism remains a scientifically incomplete causal account. The incompleteness is not converted into an untyped causal entity or treated as a complete causal explanation.

8.13 Common-stage causal-realization profile

For each admitted stage s , define:

Definition 8.2 (Common-Stage Causal-Realization Profile).

$$\mathfrak{G}_C(s) := \left(A \mapsto \mathcal{C}_A^{\text{act}}(s) \right)_{A \in \mathcal{S}_{\text{phys}}(s)}. \quad (140)$$

This profile may contain an empty causal set in a dependency structure in which the relevant causal principle is not imposed.

In a governing V38/F18 realization satisfying UCC and CRP:

$$\{\text{UCC}, \text{CRP}\} \vdash \forall s \in \mathcal{S}_C^{\text{tot}} \forall A \in \mathcal{S}_{\text{phys}}(s), \quad \mathcal{C}_A^{\text{act}}(s) \neq \emptyset. \quad (141)$$

The existence of the causal-realization profile does not imply a common cause:

$$\text{Defined}(\mathfrak{G}_C(s)) \not\Rightarrow \exists c \forall A \in \mathcal{S}_{\text{phys}}(s), \quad c \in \mathcal{C}_A^{\text{act}}(s). \quad (142)$$

Nor does it imply one common causal mechanism:

$$\text{Defined}(\mathfrak{G}_C(s)) \not\Rightarrow \text{OneUniversalCausalMechanism}(s). \quad (143)$$

9. Complete-Population Physical Realization

9.1 Motivation and scope

V36/F16 [2] made complete-population physical-change coverage explicit. V37/F17 then introduced the dependent state, change, causal-realization, and complete physical-realization profiles

used to represent that coverage without erasing system-specific typing. V38/F18 retains that architecture under its governing temporal-status discipline; it does not present the profile family as a new V38 ontological or representational primitive.

The one-global-stage incidence definitions identify the complete then-realized qualified population at each member of the common formal cosmic-stage domain. CMA independently requires objective common-stage co-presence of that population, while UCC independently requires system-specific actual physical-change realization in every member of that population and throughout each realized identity range. The retained profile architecture represents the corresponding population, state, change, and causal roles without redefining time or confusing these definitionally distinct commitments.

9.2 Aligned domains in the governing theory

The state profile has domain:

$$\text{dom } \mathfrak{X}_C(s) = \mathcal{S}_{\text{phys}}(s). \quad (144)$$

The change profile has domain:

$$\text{dom } \mathfrak{D}_C(s) = \mathcal{B}_\Delta(s). \quad (145)$$

Under UCC:

$$\text{UCC} \implies \text{dom } \mathfrak{D}_C(s) = \mathcal{S}_{\text{phys}}(s). \quad (146)$$

The causal-realization profile is indexed by $\mathcal{S}_{\text{phys}}(s)$, and under UCC plus CRP every indexed system has a nonempty actual causal set.

Therefore:

$$\begin{aligned} \text{dom } \mathfrak{X}_C(s) &= \mathcal{S}_{\text{phys}}(s), \\ \{\text{UCC}, \text{CRP}\} \vdash \forall s \in \mathcal{S}_C^{\text{tot}}, \quad \text{dom } \mathfrak{D}_C(s) &= \mathcal{S}_{\text{phys}}(s), \\ \text{dom } \mathfrak{G}_C(s) &= \mathcal{S}_{\text{phys}}(s). \end{aligned} \quad (147)$$

With CSPP:

$$\{\text{CSPP}, \text{UCC}, \text{CRP}\} \vdash \forall s \in \mathcal{S}_C^{\text{tot}}, \quad \mathcal{S}_{\text{phys}}(s) \neq \emptyset. \quad (148)$$

The global-stage architecture supplies the common formal cosmic-stage domain for that population. CMA independently supplies objective common-stage co-presence, while UCC requires complete actual-change coverage of that population.

9.3 Definition of the complete physical-realization profile

Definition 9.1 (Complete-Population Common-Stage Physical-Realization Profile). In a governing V38/F18 realization, define:

$$\boxed{\mathfrak{R}_C(s) := (\mathcal{S}_{\text{phys}}(s), \mathfrak{X}_C(s), \mathfrak{D}_C(s), \mathfrak{G}_C(s))}. \quad (149)$$

The profile is indexed by the complete admitted physical-system population $\mathcal{S}_{\text{phys}}(s)$ under the governing ontic systemhood and numerical-identity conditions. Its completeness is exactly completeness of representation over that population. It is not a claim to enumerate every constituent of $\mathcal{U}_C^{\text{phys}}$: physical factors are not converted into system-profile entries and appear only where an explicitly typed physical relation or causal contribution requires them. The profile

supplies neither a universal system boundary nor a universal identity criterion, common state space, common change codomain, common causal mechanism, or exhaustive set of physical relations at s .

9.4 Illustrative typed physical instantiation

The following example is explanatory only. It introduces no new axiom, postulate, physical dynamics, system-boundary rule, identity criterion, or empirical claim. Consider two qualified physical clock systems $C, D \in \mathcal{S}_{\text{phys}}(s)$ in a governing realization satisfying UCC and CRP. Their stage-relative entries may be written as

$$X_C(s) \in \mathcal{X}_C, \quad \Delta_C^{\text{phys}}(s) \in \Xi_C, \quad \mathcal{C}_C^{\text{act}}(s) \neq \emptyset, \quad (150)$$

$$X_D(s) \in \mathcal{X}_D, \quad \Delta_D^{\text{phys}}(s) \in \Xi_D, \quad \mathcal{C}_D^{\text{act}}(s) \neq \emptyset. \quad (151)$$

The one-global-stage architecture fixes the common formal cosmic-stage domain, while CMA fixes objective common-stage co-presence of the complete then-realized qualified population containing C and D . The corresponding CMA co-presence statement is

$$\text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s). \quad (152)$$

Separately, UCC's complete actual-change burden requires actual physical change in every qualified system represented at that member; in this example it includes $\text{PhysReal}_C^+(s) \wedge \text{PhysReal}_D^+(s)$. Neither commitment requires $X_C(s) = X_D(s)$, identical change content, identical causal contributors, or identical later clock records. Distinct apparatus conditions, motion, gravitational environment, interrogation, and other independently specified physical dynamics may produce different mapped clock outputs while both physical clock systems remain members of the same common cosmic change stage. The example therefore instantiates the four profile roles without turning a clock output, proper-time functional, metric interval, or model parameter into the entity denoted by T_{ITOF} . The quantitative clock branches in the later application sections supply the corresponding application-level laws and measurement maps.

The four components answer four distinct questions:

- (i) $\mathcal{S}_{\text{phys}}(s)$ identifies the complete qualified physical-system population whose numerical identities are realized at s ;
- (ii) $\mathfrak{X}_C(s)$ represents the system-specific physical states realized by that population;
- (iii) $\mathfrak{D}_C(s)$ represents the system-specific physical-change contents realized by that population under UCC;
- (iv) $\mathfrak{G}_C(s)$ represents the actual physical causal sets associated with those changes under CRP.

The profile is analytical and representational. It is not an additional physical substance existing alongside the systems.

Numerical-identity realization requires no fifth generic profile coordinate. At stage s , realization of numerical identity is already typed by $A \in \mathcal{S}_{\text{phys}}(s) \iff s \in I_A$, while formation, ending, and successor attribution are governed separately by the identity-history and lifecycle architecture. A universal $\text{IdentityStatus}_A(s)$ therefore does not follow from the foundational profile and would require an independently defined physical role.

9.5 Projection structure and conservative content

The four defining components are recoverable by canonical projections:

$$\pi_{\text{pop}}(\mathfrak{R}_C(s)) = \mathcal{S}_{\text{phys}}(s), \quad (153)$$

$$\pi_{\text{state}}(\mathfrak{R}_C(s)) = \mathfrak{X}_C(s), \quad (154)$$

$$\pi_{\text{change}}(\mathfrak{R}_C(s)) = \mathfrak{D}_C(s), \quad (155)$$

$$\pi_{\text{cause}}(\mathfrak{R}_C(s)) = \mathfrak{G}_C(s). \quad (156)$$

Accordingly, once the four components are fixed, the profile introduces no additional independent degree of freedom:

$$\text{ComponentsFixed}(\mathcal{S}_{\text{phys}}(s), \mathfrak{X}_C(s), \mathfrak{D}_C(s), \mathfrak{G}_C(s)) \implies \text{ProfileUniquelyFixed}(\mathfrak{R}_C(s)). \quad (157)$$

This is the formal sense in which the V37/F17 profile, retained and in V38/F18 is an integrating construction rather than an ontological primitive.

9.6 Relational augmentation without temporal enlargement

Population, state, change, and causal-set coverage do not exhaust every physically admissible relation among then-realized systems. For a declared physical model M , let

$$\mathcal{R}_M(s) \quad (158)$$

denote the independently warranted stage-relative family of additional physical relations used by that model, such as interaction, constraint, correlation, composition, or coupling relations. A model-relative augmentation is defined by

$$\mathfrak{R}_C^{[M]}(s) := (\mathfrak{R}_C(s), \mathcal{R}_M(s)). \quad (159)$$

The augmentation is application-level and is permitted only where the added relations are physically typed and independently warranted. It neither changes the population-completeness meaning of the foundational profile nor enlarges the temporal referent:

$$\mathfrak{R}_C^{[M]}(s) \not\equiv_{\text{type}} T_{\text{ITOF}}, \quad \mathfrak{R}_C^{[M]}(s) \not\equiv_{\text{type}} \text{TemporalComponent}. \quad (160)$$

Different admissible physical models may therefore enrich the relational content associated with the same common cosmic change stage without generating different times or changing the V38/F18 definition of time.

9.7 Population completeness and representational scope

Completeness refers to the domain of qualified systems represented at the stage:

$$\text{ProfileDomain}(\mathfrak{R}_C(s)) = \mathcal{S}_{\text{phys}}(s). \quad (161)$$

It neither asserts physical uniformity nor exhausts every physically admissible relation among the systems:

$$\text{CompletePopulationCoverage}(\mathfrak{R}_C(s)) \not\Rightarrow \text{ExhaustivePhysicalDescriptionAt}(s). \quad (162)$$

In particular:

$$\begin{aligned} \text{CompletePopulationCoverage}(\mathfrak{R}_C(s)) &\not\Rightarrow \text{OneUniversalState}, \\ \text{CompletePopulationCoverage}(\mathfrak{R}_C(s)) &\not\Rightarrow \text{OneUniversalChangeContent}, \\ \text{CompletePopulationCoverage}(\mathfrak{R}_C(s)) &\not\Rightarrow \text{OneUniversalCausalSet}. \end{aligned} \quad (163)$$

The same non-entailment applies to a universal change magnitude, change rate, or physical mechanism. The relational augmentation of Eq. (159) supplies the model-level location for additional interaction, constraint, correlation, composition, or coupling relations. Stage unity, population completeness, physical multiplicity, and model-relative relational enrichment are therefore mutually consistent without altering temporal identity.

9.8 The realization profile is not time

The complete-population common-stage physical-realization profile is not a new temporal component:

$$\mathfrak{R}_C(s) \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (164)$$

Nor is:

$$\mathfrak{R}_C(s) \not\equiv_{\text{type}} s. \quad (165)$$

Nor does V38/F18 redefine time by adjoining the realization-profile family:

$$T_{\text{ITOF}} \not\equiv_{\text{def}} \left(\mathcal{S}_C^{\text{tot}}, \prec_C, \{\mathfrak{R}_C(s)\}_{s \in \mathcal{S}_C^{\text{tot}}} \right). \quad (166)$$

The governing time definition remains Eq. (10); the realization-profile family is not appended to that ordered pair.

The physical-realization profiles belong to the physical architecture associated with the common cosmic stages; they are not contents placed inside a temporal or cosmic container.

9.9 Population Completeness versus Epistemic Access

The complete profile is not claimed to be completely measurable or reconstructible by any observer.

Thus:

$$\text{CompletePopulationCoverage}(\mathfrak{R}_C(s)) \not\Rightarrow \text{CompleteObservation}(\mathfrak{R}_C(s)). \quad (167)$$

And:

$$\text{CompletePopulationCoverage}(\mathfrak{R}_C(s)) \not\Rightarrow \text{CompleteScientificKnowledge}(\mathfrak{R}_C(s)). \quad (168)$$

The distinction is ontological–epistemic and does not depend on observational completeness.

9.10 Full-profile consequences under CMA, UCC, and CRP

The complete-population physical-realization profile is already defined by its population, state, change, and causal components. No additional realization predicate is required. Under temporal admissibility, CMA, UCC, and CRP, the governing stage-relative conditions are:

$$\begin{aligned}
& \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \wedge \text{CMA} \wedge \text{UCC} \wedge \text{CRP} \\
& \implies \forall s \in \mathcal{S}_C^{\text{tot}}, \\
& \mathcal{S}_{\text{phys}}(s) \neq \emptyset \wedge \text{StageChangeBridge}_C(s), \\
& \forall A \in \mathcal{S}_{\text{phys}}(s), \quad \mathcal{C}_A^{\text{act}}(s) \neq \emptyset.
\end{aligned} \tag{169}$$

This is a derived consequence of already declared commitments, not a new layer or independent foundational predicate. The common formal cosmic-stage domain supplies the formal stage domain; CMA supplies objective common-stage co-presence; UCC supplies complete system-specific actual-change coverage; and CRP supplies nonempty physical causal realization for every actual-change pair.

10. Hierarchy, Composition, and Type Boundaries

The transition to composition is required by the scope of the realization commitments rather than by any claim that time itself is hierarchical. CSPP, CMA, and UCC quantify over qualified numerical physical-system identities, while many physical applications involve composites, constituents, and independently qualified subsystems sharing the same common cosmic stage. Before a universal population statement can be applied across such levels, the framework must specify when two identified systems stand in a genuine physical constituent relation and which cross-level inferences are warranted. Without that discipline, mere co-membership in $\mathcal{S}_{\text{phys}}(s)$, spatial inclusion, or material overlap could be mistaken for numerical identity, composition, causal determination, or inherited change. Accordingly, the hierarchy module types the physical-system granularity needed by the realization architecture; it does not add a hierarchical component to T_{ITOF} .

10.1 Why composition requires an explicit physical criterion

Physical reality may support several scientifically legitimate system boundaries at different organizational levels. This level-relativity concerns system individuation, not the objectivity of physical realization. A subsystem and a composite can therefore both be qualified physical-system identities when each independently satisfies the appropriate physical criteria.

Simple and composite systems must be distinguished. A simple qualified system need not be decomposable into qualified subsystems. A composite qualified system requires a physically real relation among its elements: the governing criterion must establish both interconnection and coherence at the composite level. Accordingly, a composite criterion may be represented by

$$\kappa_{\text{comp}} = (\kappa_{\text{interconnection}}, \kappa_{\text{coherence}}). \tag{170}$$

Interconnection requires physically operative relations among the relevant constituents; mere spatial proximity is insufficient. Coherence requires that those relations support the composite

as a distinguishable physical unity with system-level properties and persistence conditions; mere co-location or set membership is insufficient. The precise physical realization of these criteria is class-specific and may be structural, dynamical, organizational, or another scientifically warranted form.

A physical system may contain constituents, subsystems, components, organized substructures, or other independently identifiable physical-system identities. V38/F18 does not infer numerical identity or composition merely from linguistic description, material overlap, spatial inclusion, or analytical convenience. Composition therefore requires a declared physically warranted criterion κ consistent with the system class and granularity fixed for the application.

10.2 Stage-relative constituent relation

For $A, B \in \mathcal{U}_{\text{phys}}$, define:

$$A \triangleleft_{\kappa, s} B \quad (171)$$

to mean that, under declared physical composition criterion κ , the independently qualified numerical physical-system identity A is physically realized as a proper constituent or subsystem of numerical physical-system identity B at common cosmic change stage s .

The typing requirement is:

$$A \triangleleft_{\kappa, s} B \implies A, B \in \mathcal{S}_{\text{phys}}(s) \wedge A \neq B. \quad (172)$$

The relation concerns simultaneously realized physical identities. Ending or failure of a qualified constituent does not by itself end the composite identity:

$$A \triangleleft_{\kappa, s} B \wedge \text{End}_A(e_A) \not\Rightarrow \text{End}_B(e_B). \quad (173)$$

The composite ends only when the applicable composite identity criterion—in particular its required interconnection and coherence conditions—is no longer satisfied at the composite level.

It does not make a constituent a state of the composite:

$$A \triangleleft_{\kappa, s} B \not\Rightarrow A \equiv_{\text{type}} X_B(s). \quad (174)$$

Nor does it erase the constituent's own identity history.

10.3 Composition profile

Define:

$$\mathfrak{R}_C(s) := \{(A, B, \kappa) \mid A \triangleleft_{\kappa, s} B\}. \quad (175)$$

This profile records declared stage-relative constituent relations among qualified physical-system identities.

The definition of the composition profile does not impose one unique hierarchy or one universal tree of systems:

$$\text{Defined}(\mathfrak{R}_C(s)) \not\Rightarrow \text{OneUniqueHierarchy}(s), \quad (176)$$

$$\text{Defined}(\mathfrak{R}_C(s)) \not\Rightarrow \text{OneUniversalTreeOfSystems}(s). \quad (177)$$

Likewise, V38/F18 does not universally postulate transitivity of $\triangleleft_{\kappa,s}$. From composition membership alone, without an additional closure condition on the declared criterion κ , the transitive conclusion is not a V38/F18 consequence:

$$A \triangleleft_{\kappa,s} B \wedge B \triangleleft_{\kappa,s} C \not\Rightarrow A \triangleleft_{\kappa,s} C. \quad (178)$$

A domain-specific composition criterion may independently impose transitivity. Where

$$\text{TransitiveCompositionCriterion}(\kappa; \mathcal{A}) \quad (179)$$

is independently warranted for system class $\mathcal{A}$, the corresponding application may infer the transitive relation within that declared domain. No framework-wide transitivity follows without that additional premise.

10.4 Constituents Are Not Automatically Systems

A physical component within the boundary of B need not automatically be a member of $\mathcal{U}_{\text{phys}}$.

Therefore:

$$\text{PhysicalConstituentOf}(x, B; s) \not\Rightarrow x \in \mathcal{U}_{\text{phys}}. \quad (180)$$

The relation

$$A \triangleleft_{\kappa,s} B \quad (181)$$

is reserved for a constituent that independently satisfies the qualified physical-system identity requirements.

This prevents arbitrary decomposition from producing an unlimited collection of nominal systems merely by description.

10.5 UCC at each independently qualified system level

If:

$$A \triangleleft_{\kappa,s} B, \quad (182)$$

then:

$$A, B \in \mathcal{S}_{\text{phys}}(s). \quad (183)$$

Under UCC:

$$A \triangleleft_{\kappa,s} B \wedge \text{UCC} \Rightarrow \text{PhysReal}_A^+(s) \wedge \text{PhysReal}_B^+(s). \quad (184)$$

These are two system-specific physical-change realizations.

The result does not imply:

$$A \triangleleft_{\kappa,s} B \wedge \text{UCC} \not\Rightarrow \Delta_A^{\text{phys}}(s) = \Delta_B^{\text{phys}}(s). \quad (185)$$

Nor does it imply:

$$A \triangleleft_{\kappa,s} B \not\Rightarrow \Xi_A = \Xi_B. \quad (186)$$

10.6 Cross-Level Non-Transfer Principle

Principle 10.1 (Cross-Level Non-Transfer Principle). Physical composition does not by itself transfer a physical state, change content, causal description, or numerical identity from one qualified system level to another.

Formally:

$$A \triangleleft_{\kappa,s} B \not\Rightarrow \text{PhysicallyDetermines}_{\kappa} \left(\Delta_A^{\text{phys}}(s); \Delta_B^{\text{phys}}(s) \right). \quad (187)$$

Likewise:

$$A \triangleleft_{\kappa,s} B \not\Rightarrow \text{PhysicallyDetermines}_{\kappa} \left(\Delta_B^{\text{phys}}(s); \Delta_A^{\text{phys}}(s) \right). \quad (188)$$

Here $\text{PhysicallyDetermines}_{\kappa}$ is not a newly assumed physical relation. It denotes whatever specific cross-level physical dependence an application would need to establish.

The principle therefore states that composition alone supplies no such dependence.

10.7 Composite Change Is Not a Universal Sum

Even where qualified constituents

$$A_1, \dots, A_n$$

are physically realized within composite B , composition alone does not imply an additive change law:

$$\left[\bigwedge_{i=1}^n A_i \triangleleft_{\kappa_i,s} B \right] \not\Rightarrow \Delta_B^{\text{phys}}(s) = \sum_{i=1}^n \Delta_{A_i}^{\text{phys}}(s). \quad (189)$$

Such an expression may be mathematically ill typed because:

$$\Xi_{A_i} \neq \Xi_{A_j} \quad (190)$$

may hold and no universal addition operation is supplied.

A valid cross-level quantitative model requires its own physical variables, mapping rules, coupling relations, aggregation rules, and empirical warrant.

10.8 Hierarchical causation

Where $A \triangleleft_{\kappa,s} B$, A lies within the declared physical boundary of B under criterion κ .

A physically operative contribution associated with that constituent is therefore treated through the internal physical basis of B under the applicable causal attribution.

It is not converted into an influencing physical-system contribution merely because A also possesses an independently qualified physical-system identity.

Thus the causal classification depends jointly on:

$$\langle \text{NumericalIdentity}, \text{DeclaredSystemBoundary}, \text{PhysicalCausalRole} \rangle. \quad (191)$$

The same physical reality may therefore be described under distinct legitimate system boundaries without collapsing those boundaries or counting one contributor twice within one declared causal attribution.

10.9 Hierarchy does not divide the common cosmic stage

If:

$$A \triangleleft_{\kappa,s} B, \quad (192)$$

both identities are realized at the same common cosmic change stage s .

The constituent does not possess a lower-level time while the composite possesses a higher-level time.

Thus:

$$A \triangleleft_{\kappa,s} B \not\Rightarrow \text{PrivateTime}(A) \vee \text{PrivateTime}(B). \quad (193)$$

Hierarchy belongs to physical organization, not to multiplication of temporal orders.

11. Numerical Identity and Formation Boundaries

11.1 Governing identity notion

Unless an application explicitly declares another domain-specific identity notion, V38/F18 uses numerical physical-system identity. Here *numerical identity* means identity of the physical system itself: whether two stage-indexed realizations concern one and the same physical system. It does not mean a numerical identifier, a stage number, a coordinate, a metric value, or an assigned ordinal.

The relevant question is:

$$\text{IsThisTheSamePhysicalSystem?} \quad (194)$$

rather than:

$$\text{DoesThisSystemHaveTheSameState?} \quad (195)$$

Accordingly:

$$\text{SameNumericalIdentity}_A(r, s) \not\Rightarrow X_A(r) = X_A(s). \quad (196)$$

Identity persistence is compatible with physical change.

11.2 Class-indexed physical-system identity qualification

V38/F18 does not postulate one universal empirical numerical-identity criterion for every physical-system class. For each declared class $\mathcal{K}$, define an application-level identity-qualification profile

$$\mathfrak{Q}_{\mathcal{K}}^{\text{id}} := (\kappa_{\text{sys}}, \kappa_{\text{boundary}}, \kappa_{\text{id}}, \kappa_{\text{persist}}, \kappa_{\text{form}}, \kappa_{\text{end}})_{\mathcal{K}}. \quad (197)$$

The components specify, respectively, physical-system qualification, system boundary, numerical identity, persistence, formation, and ending for the declared class and organizational granularity. Physical realization is objective; the selection and tracking of a system identity are level- and criterion-relative within that objective physical organization, not observer-subjective or arbitrary. For composite systems, κ_{sys} and the persistence and ending criteria must include the physically warranted interconnection and coherence conditions appropriate to the composite level. These are application-level physical criteria. They are not supplied by time, CMA, or UCC.

For an empirical or model-based protocol P , identity application is admissible only if the profile

is fixed prospectively before outcome interpretation, internally consistent, physically warranted for the declared class, and applicable to the system under study:

$$\begin{aligned}
& \text{IdentityApplicationAdmissible}(A; \mathcal{K}, P) \\
& \implies \text{PredeclaredAndFrozen}(\mathfrak{Q}_{\mathcal{K}}^{\text{id}}, P) \\
& \quad \wedge \text{InternallyConsistent}(\mathfrak{Q}_{\mathcal{K}}^{\text{id}}) \\
& \quad \wedge \text{PhysicallyWarrantedForClass}(\mathfrak{Q}_{\mathcal{K}}^{\text{id}}, \mathcal{K}) \\
& \quad \wedge \text{DomainApplicable}(\mathfrak{Q}_{\mathcal{K}}^{\text{id}}, A, P).
\end{aligned} \tag{198}$$

These are necessary admissibility conditions, not a universal sufficiency claim; a physical domain may require additional criteria.

Prospective freezing is protocol-relative rather than permanent. It forbids changing the system boundary or identity criterion after observing the outcome of P in order to manufacture or rescue an attribution. It does not forbid later science from adopting a better physically warranted profile in a new protocol P' :

$$\text{FrozenFor}(\mathfrak{Q}_{\mathcal{K}}^{\text{id}}, P) \not\Rightarrow \text{PermanentlyImmutableAcrossFutureProtocols}. \tag{199}$$

Application admissibility must also be distinguished from the admissibility of a specific identity attribution. For an attribution type $\chi \in \{\text{persistence, formation, ending, successor}\}$, require

$$\begin{aligned}
& \text{IdentityAttributionAdmissible}(A; \mathcal{K}, P, \chi) \\
& \implies \text{IdentityApplicationAdmissible}(A; \mathcal{K}, P) \wedge \text{SatisfiesRelevantIdentityCriterion}(A; \mathcal{K}, P, \chi).
\end{aligned} \tag{200}$$

A sound profile does not by itself establish that formation, persistence, ending, or successor production actually occurred; the relevant evidence or model output must satisfy the corresponding criterion.

11.3 Material continuity is not sufficient for numerical identity

A later system may:

$$\begin{aligned}
& \text{contain earlier constituents,} \quad \text{contain transferred matter,} \quad \text{occupy a similar region,} \\
& \text{perform a similar function,} \quad \text{or resemble an earlier system}
\end{aligned} \tag{201}$$

without being numerically identical to that earlier system.

Hence:

$$\text{MaterialOverlap}(A, B) \not\Rightarrow A = B. \tag{202}$$

And:

$$\text{FunctionalEquivalence}(A, B) \not\Rightarrow A = B. \tag{203}$$

The applicable physical identity criterion governs the attribution.

11.4 Identity-Realization Convexity

Postulate 11.1 (Identity-Realization Convexity). For every $A \in \mathcal{U}_{\text{phys}}$ and all $r, s, t \in \mathcal{S}_C^{\text{tot}}$:

$$\boxed{r \in I_A \wedge t \in I_A \wedge r \prec_C s \wedge s \prec_C t \implies s \in I_A.} \quad (204)$$

Identity-Realization Convexity is an independent foundational identity postulate. It prevents an internal gap in one numerical physical-system identity.

Equivalently:

$$r, t \in I_A \wedge r \prec_C s \prec_C t \implies \neg(s \notin I_A). \quad (205)$$

Identity-Realization Convexity imposes no metric duration, stage count, equal-stage spacing, state constancy, or change-magnitude constancy. It constrains only membership continuity of one numerical identity in the universal order.

11.5 Actual Formation Boundary

Postulate 11.2 (Actual Formation Boundary (AFB)). For every qualified physical-system identity, its realized identity range $I_A \subseteq \mathcal{S}_C^{\text{tot}}$ has one unique least member with respect to the one common cosmic ordering $\prec_C$:

$$\boxed{\text{AFB} \iff \forall A \in \mathcal{U}_{\text{phys}} \exists! f \in I_A [\nexists r \in I_A (r \prec_C f)]}. \quad (206)$$

The member f_A is the formation boundary of numerical identity A inside the same universal cosmic-stage domain used by every qualified system. It is not a private first time for A , does not imply Cosmic Origin, and does not make the common stage a container in which the system is placed. Under UCC, A realizes actual system-specific physical change at its formation boundary f_A . Where independently warranted physics identifies a physical formation process at that boundary, that process may constitute or contribute to the realized formation change. AFB and UCC alone do not determine the formation mechanism or causal contributor. A prior member of the same numerical identity range is not required.

AFB is an independent identity-range postulate. Its universal quantification over $\mathcal{U}_{\text{phys}}$ is a foundational burden, not a consequence established by the temporal definition, CMA, UCC, or the optional non-termination condition. Empirical application to a declared system class still requires independently warranted identity-qualification criteria. AFB constrains only the lower boundary of each realized identity range within the one common cosmic-stage domain. The least member belongs to that same cosmic-stage domain. The incidence definitions identify the qualified population whose identity ranges contain that member; CMA, not incidence alone, supplies objective common-stage co-presence of that population. It is not a system-private stage, does not mark the beginning of physical change in the cosmic succession, and does not introduce any priority of one system's change over another system's change at the same common cosmic stage.

The asymmetry between AFB and optional UEIE is therefore an asymmetry of identity-range commitments, not of physical-change realization. AFB postulates a least member for every declared qualified identity range. UEIE would add the additional universal claim that every such identity range also possesses an ending member. Nothing in the temporal definition, CMA, UCC, or AFB entails that universal ending claim; UEIE accordingly remains an optional lifecycle

postulate requiring independent physical warrant for the declared system domain.

Let the unique least member be:

$$f_A. \quad (207)$$

Define:

$$f : \mathcal{U}_{\text{phys}} \longrightarrow \mathcal{S}_C^{\text{tot}}, \quad f(A) = f_A. \quad (208)$$

Within AFB, formation denotes realization of the physical-system identity at the least member f_A of its identity range in the one common cosmic-stage domain. This is an identity-boundary statement. It neither introduces a private stage for A nor defines an onset of physical change in the cosmic succession.

For every $r \in \mathcal{S}_C^{\text{tot}}$:

$$r \prec_C f_A \implies \neg \text{ExistsAs}(A, r). \quad (209)$$

Equation (209) is an identity-incidence statement only: if $r \prec_C f_A$, then $r \notin I_A$. It does not imply absence of other qualified systems, influencing physical factors, or physical change at r . Other qualified physical systems realized at such stages may possess their own identity-bounded histories. Physical factors may be realized or influential there without thereby acquiring a system identity range or a system history.

11.6 Formation change

Formation change denotes the system-specific physical change realized at the common cosmic stage f_A at which the identity range of A has its least member. It is not a private or system-specific stage, is not the beginning of physical change in the common succession, and is not defined as a finite difference between two states of a pre-existing A .

Define:

$$\text{FormationChange}_A(s) \iff s = f_A \wedge \text{PhysReal}_A^+(s). \quad (210)$$

AFB and UCC give:

$$\{\text{AFB}, \text{UCC}\} \vdash \forall A \in \mathcal{U}_{\text{phys}}, \quad \text{FormationChange}_A(f_A). \quad (211)$$

This conclusion assigns no priority to formation change relative to changes of other qualified systems realized at f_A . By UCC, every $B \in \mathcal{S}_{\text{phys}}(f_A)$ satisfies $\text{PhysReal}_B^+(f_A)$ at that same common stage.

The causal contributors to formation change remain physical contributors in the sense of CRP; T_{TOF} , f_A , $\prec_C$, CMA, and UCC are not additional causal-source classes.

Under UCC and CRP:

$$\{\text{AFB}, \text{UCC}, \text{CRP}\} \vdash \forall A \in \mathcal{U}_{\text{phys}}, \quad \mathcal{C}_A^{\text{act}}(f_A) \neq \emptyset. \quad (212)$$

11.7 Formation does not imply cosmic origin

AFB concerns identity-range boundaries within the one common cosmic-stage domain. Different values of f_A and f_B , where they differ, are different members of that same domain; they are not private stages belonging to different systems.

Therefore:

$$\text{AFB} \not\Rightarrow \text{CosmicOrigin}. \quad (213)$$

Only the optional Cosmic Origin postulate determines whether $\mathcal{S}_C^{\text{tot}}$ possesses a least common cosmic change stage.

12. Identity-Bounded Physical Histories

12.1 History domain

Each qualified numerical physical-system identity has a physical history only over the common cosmic change stages at which that identity is realized:

$$I_A \subseteq \mathcal{S}_C^{\text{tot}}. \quad (214)$$

The restriction:

$$\prec_C|_{I_A} \quad (215)$$

does not create a new ordering relation. It is the restriction of the same one universal cosmic ordering to the identity-realization range of A .

Thus:

$$\text{OrderOfHistory}(A) = \prec_C|_{I_A}. \quad (216)$$

No independent private ordering is introduced for A .

12.2 Formal physical-history representation

In a governing V38/F18 realization, UCC gives:

$$I_A^\Delta = I_A. \quad (217)$$

Therefore the physical-change-content map is well typed throughout the realized identity range.

Define:

$$\mathcal{H}_A := (I_A, \prec_C|_{I_A}, X_A, \Delta_A^{\text{phys}}). \quad (218)$$

$\mathcal{H}_A$ is a formal representation of the actual physical history of A . It is not the actual physical system and is not the temporal referent.

Hence:

$$\mathcal{H}_A \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (219)$$

And:

$$\mathcal{H}_A \not\equiv_{\text{type}} A. \quad (220)$$

12.3 Many physical histories within one cosmic extension

V38/F18 assigns one system-indexed physical history representation $\mathcal{H}_A$ to each qualified physical-system identity $A \in \mathcal{U}_{\text{phys}}$. There is no single physical system-history that replaces this family: the physical histories are as system-specific as the identities that bear them, without any claim

that their total cardinality is presently known. The framework does not assign a private temporal succession to any of them. Every history is restricted from the same universal ordering through its own identity range.

For distinct qualified systems:

$$A \neq B \not\Rightarrow \mathcal{H}_A = \mathcal{H}_B. \quad (221)$$

Their identity domains may overlap:

$$I_A \cap I_B \neq \emptyset. \quad (222)$$

At every shared member:

$$s \in I_A \cap I_B \quad (223)$$

the systems share the same common cosmic change stage s , while retaining distinct physical states, change contents, causal profiles, and numerical identities.

Thus:

$$\text{ManyPhysicalHistories} \not\Rightarrow \text{ManyTimes}. \quad (224)$$

12.4 Hierarchical histories

If:

$$A \triangleleft_{\kappa,s} B, \quad (225)$$

both A and B possess their own identity-bounded physical histories.

The history of the constituent is not established as a subhistory of the composite merely because the constituent lies physically within the composite at s . In particular, stage-relative composition alone does not entail containment of the constituent's entire identity range within the composite's identity range:

$$A \triangleleft_{\kappa,s} B \not\Rightarrow I_A \subseteq I_B. \quad (226)$$

The system histories may overlap in common cosmic change-stage domain while remaining numerically and physically distinct.

12.5 History recurrence and persistence

For $r, s \in I_A$ with:

$$r \prec_C s, \quad (227)$$

it is possible for a declared state criterion K_A to satisfy:

$$K_A(X_A(r), X_A(s)) = \text{Equivalent}. \quad (228)$$

The later physical realization remains later:

$$r \prec_C s \implies \neg(s \prec_C r). \quad (229)$$

State recurrence does not constitute historical reversal.

13. Historical Accumulation and Present Resultant

13.1 Strictly earlier identity history

For $A \in \mathcal{U}_{\text{phys}}$ and $s \in I_A$, define:

$$I_A^{<s} := \{r \in I_A \mid r \prec_C s\}. \quad (230)$$

Under UCC:

$$\text{UCC} \wedge I_A^{<s} \neq \emptyset \implies \forall r \in I_A^{<s}, \quad \text{PhysReal}_A^+(r). \quad (231)$$

This establishes actual earlier system-specific physical change without assigning a metric duration, stage count, or universal cumulative magnitude.

13.2 Historical Physical Accumulation

Definition 13.1 (Historical Physical Accumulation). For $A \in \mathcal{U}_{\text{phys}}$ and $s \in I_A$ with $I_A^{<s} \neq \emptyset$, the expression

$$\text{HistoricalPhysicalAccumulation}_A^{<s} \quad (232)$$

designates the totality of system-specific physical change actually realized strictly earlier than s in the physical history of A .

The designation is historical.

It is not defined as:

$$\text{HistoricalPhysicalAccumulation}_A^{<s} \not\equiv_{\text{def}} \sum_{r \in I_A^{<s}} \Delta_A^{\text{phys}}(r). \quad (233)$$

No universal addition operation across physical-change contents is assumed.

Historical accumulation is also not identical to the formal earlier-history representation:

$$\text{HistoricalPhysicalAccumulation}_A^{<s} \not\equiv_{\text{def}} \mathcal{H}_A^{<s}. \quad (234)$$

13.3 The physical past is not a stored present object

Historical physical accumulation is not a present physical object:

$$\neg \text{PresentPhysicalObjectAt}(\text{HistoricalPhysicalAccumulation}_A^{<s}; s). \quad (235)$$

Nor is it an additional causal-source class:

$$\text{HistoricalPhysicalAccumulation}_A^{<s} \not\equiv_{\text{type}} \text{PhysicalCausalContributor}. \quad (236)$$

This does not deny persistence of physical effects. It distinguishes an earlier physical occurrence from the present physical embodiment of an effect produced by that occurrence.

13.4 Persistence and transformation of earlier effects

Earlier physical change may produce effects that:

$$\begin{aligned} & \text{persist, transform, combine, diminish,} \\ & \text{intensify, be compensated, or cease to remain embodied.} \end{aligned} \quad (237)$$

Therefore:

$$\text{EarlierChangeOccurred}(A; r) \wedge r \prec_C s \not\Rightarrow \text{EarlierEffectStillEmbodied}(A; r; s). \quad (238)$$

Where an earlier effect remains physically embodied at s , that embodiment belongs to the present developed condition:

$$X_A(s). \quad (239)$$

Where it is presently causally operative, its present physical role belongs to the appropriate current causal-source class.

No past object acts from an earlier common cosmic change stage as an additional causal source at s .

13.5 Present cumulative physical resultant

Let:

$$\text{EmbodiedEarlierEffects}_A(X_A(s); s) \quad (240)$$

state that retained or transformed effects originating in earlier realized physical change remain physically embodied in the present condition $X_A(s)$.

Definition 13.2 (Present Cumulative Physical Resultant).

$$\text{CumulativePhysicalResultThrough}_A(s) \iff \text{EmbodiedEarlierEffects}_A(X_A(s); s). \quad (241)$$

This is a truth-valued statement about the present developed physical condition. It does not introduce a new physical object or state variable.

Thus:

$$\text{HistoricalPhysicalAccumulation}_A^{<s} \not\equiv_{\text{def}} \text{CumulativePhysicalResultThrough}_A(s). \quad (242)$$

And:

$$\begin{aligned} & \text{PairwiseDefDistinct} \left(\mathcal{H}_A^{<s}, \text{HistoricalPhysicalAccumulation}_A^{<s}, \right. \\ & \left. \text{CumulativePhysicalResultThrough}_A(s) \right). \end{aligned} \quad (243)$$

13.6 UCC does not imply retained effects

UCC requires actual physical change.

It does not require every effect of earlier physical change to remain physically embodied.

Therefore:

$$I_A^{<s} \neq \emptyset \wedge \text{UCC} \not\Rightarrow \text{CumulativePhysicalResultThrough}_A(s). \quad (244)$$

Likewise:

$$\text{UCC} \not\Rightarrow \text{MonotonicCumulativeGrowth}(A). \quad (245)$$

No universal accumulation scalar, common accumulation unit, or cross-system ranking follows from UCC.

14. Identity Ending as Final Transformation

14.1 Identity-ending transformation

Let:

$$\text{IdentityEndingTransformation}(A; e) \quad (246)$$

denote the local primitive physical classification that the transformation physically realized in A at e satisfies the applicable numerical physical-system identity-ending criterion.

This local predicate does not itself quantify over all later common cosmic change stages. Functional failure, last observation, loss of usefulness, loss of a selected property, or destruction of one constituent is not by itself an identity-ending transformation. Any such condition constitutes identity ending only where the applicable physical identity criterion establishes cessation of the numerical identity itself.

14.2 Definition of physical-system identity ending

Definition 14.1 (Physical-System Identity Ending). For $A \in \mathcal{U}_{\text{phys}}$ and $e \in \mathcal{S}_C^{\text{tot}}$:

$$\boxed{\text{End}_A(e) \iff e \in I_A \wedge \text{IdentityEndingTransformation}(A; e) \wedge \forall t \in \mathcal{S}_C^{\text{tot}} (e \prec_C t \implies t \notin I_A).} \quad (247)$$

The ending stage e is the final member of the identity-realization range of A .

It is not thereby a final stage of the cosmic extension; coincidence with a greatest cosmic stage, if one exists, is a separate cosmological possibility.

Thus:

$$\text{End}_A(e) \wedge \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \implies \exists t \in \mathcal{S}_C^{\text{tot}}, \quad e \prec_C t. \quad (248)$$

14.3 UCC remains active at the ending boundary

From:

$$\text{End}_A(e) \implies e \in I_A, \quad (249)$$

UCC gives:

$$\text{End}_A(e) \wedge \text{UCC} \implies \text{PhysReal}_A^+(e). \quad (250)$$

The system does not first become physically static and then end outside its own physical development.

Define:

$$\Delta_A^{\text{end}}(e) := \Delta_A^{\text{phys}}(e), \quad \text{when } \text{End}_A(e) \wedge \text{UCC}. \quad (251)$$

The superscript end classifies the system-specific physical-change content relative to the identity boundary.

It does not introduce a separate type of change:

$$\Delta_A^{\text{end}}(e) \not\equiv_{\text{type}} \text{IndependentTerminalProcess}. \quad (252)$$

14.4 Uniqueness of ending

Proposition 14.2 (Uniqueness of Identity Ending). Under Strict Cosmic Ordering:

$$\begin{aligned} \text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) \vdash \forall A \in \mathcal{U}_{\text{phys}} \forall e_1, e_2 \in \mathcal{S}_C^{\text{tot}}, \\ \text{End}_A(e_1) \wedge \text{End}_A(e_2) \implies e_1 = e_2. \end{aligned} \quad (253)$$

If two distinct ending members were assumed, strict total ordering would place one earlier than the other. The earlier ending condition would then exclude the same numerical identity from the later member.

14.5 Functional failure remains distinct from ending

For any declared functional criterion Γ :

$$\text{FunctionalFailure}_\Gamma(A; s) \not\Rightarrow \text{End}_A(s). \quad (254)$$

Conversely:

$$\text{End}_A(e) \not\Rightarrow \text{FunctionalFailure}_\Gamma(A; e). \quad (255)$$

A system may retain its numerical identity while damaged, inactive, diseased, inefficient, or non-operational.

An identity may also end through transformation, division, fusion, merger, absorption, dissolution, or reorganization without an independently identified earlier functional-failure stage.

14.6 Ending and earlier physical history

Where:

$$I_A^{<e} \neq \emptyset \quad (256)$$

and:

$$\text{End}_A(e) \wedge \text{UCC}, \quad (257)$$

the earlier and ending changes belong to one identity-bounded development:

$$\left[\forall r \in I_A^{<e}, \quad \text{PhysReal}_A^+(r) \right] \wedge \text{PhysReal}_A^+(e). \quad (258)$$

This is stagewise physical-change actuality without an admitted change-null member relative to the identity range.

It is not mathematical continuity, differentiability, a metric trajectory, or an infinitesimal-change claim.

14.7 Ending configuration

For an actual ending define:

$$\mathfrak{R}_A^{\text{end}}(e) := \left(X_A(e), \Delta_A^{\text{end}}(e), \mathfrak{C}_A(e) \right). \quad (259)$$

The components distinguish:

- (i) the developed physical state at ending;
- (ii) the system-specific physical-change content classified relative to the identity-ending boundary;
- (iii) the actual causal profile operative at that same ending stage.

The tuple is not chronological:

$$\text{Defined}(\mathfrak{R}_A^{\text{end}}(e)) \not\Rightarrow \text{SequentialThreeStepEnding}. \quad (260)$$

All three terms concern one common cosmic change stage and are analytically distinguished by role. At the ending stage, the final system-specific change and the developed physical state of the ending identity are realized together at that same common cosmic change stage. The strictly earlier changes remain the identity's historical physical accumulation; they are not converted into a second present object. Whatever retained or transformed physical result of that history remains embodied at ending is present through $X_A(e)$, together with the final change $\Delta_A^{\text{end}}(e)$, and any presently operative effects enter the already governed causal-source classes. This preserves the cumulative physical development of the system without treating its past occurrences as co-present causal objects.

14.8 Physical Identity-Ending Causation Principle

Postulate 14.3 (Physical Identity-Ending Causation Principle (PIECP)). Every actual numerical physical-system identity ending has at least one physically admissible contributor from the already governed actual causal set at the ending stage that physically contributes specifically to the identity-ending transformation:

$\begin{aligned} \text{PIECP} &\iff \forall A \in \mathcal{U}_{\text{phys}} \forall e \in \mathcal{S}_C^{\text{tot}}, \\ &\quad \text{End}_A(e) \implies \exists c \in \mathcal{C}_A^{\text{act}}(e) : \\ &\quad \text{PhysicallyContributes}(c; \text{IdentityEndingTransformation}(A; e)). \end{aligned}$	(261)
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The ending transformation is the final system-specific change of that numerical identity at the common stage e . The earlier physical history of A remains its own historical sequence of realized changes; it is not converted into an additional causal substance at ending. Only effects of earlier change that are still physically retained or transformed in the present condition of A , together with other actually operative contributors, can enter the ending-stage causal account. Identity ending does not by itself terminate the cosmic succession or require production of a successor.

PIECP is an independent ending-specific causal postulate with a narrower role than CRP.

CRP establishes nonempty causal realization of actual physical change.

PIECP requires at least one already admissible causal contributor to be physically implicated specifically in the identity-ending transformation.

Thus:

$$\text{CRP} \wedge \text{End}_A(e) \not\Rightarrow \text{PIECP}. \quad (262)$$

PIECP introduces no additional causal-source class.

14.9 Accumulation is not an independent ending cause

Neither historical physical accumulation nor the present cumulative physical resultant is an independently acting ending cause. Historical accumulation is a historical designation rather than a present causal object. For the present cumulative-resultant predicate:

$$\text{CumulativePhysicalResultThrough}_A(e) \not\Rightarrow \text{IdentityEndingTransformation}(A; e). \quad (263)$$

And:

$$I_A^{<e} \neq \emptyset \not\Rightarrow \text{End}_A(e). \quad (264)$$

Where earlier effects remain embodied and causally operative at ending, their present causal role is classified through the existing physical causal-source architecture.

15. Lifecycle Boundaries and Conditional Successors

15.1 Completed numerical identity

Define:

$$\text{HistoryComplete}(A) \iff \exists e \in I_A \text{ End}_A(e). \quad (265)$$

Let:

$$\mathcal{U}_{\text{phys}}^{\text{end}} := \{A \in \mathcal{U}_{\text{phys}} \mid \text{HistoryComplete}(A)\}. \quad (266)$$

For ended identities:

$$e : \mathcal{U}_{\text{phys}}^{\text{end}} \longrightarrow \mathcal{S}_{\text{C}}^{\text{tot}}, \quad e(A) = e_A. \quad (267)$$

The map remains partial relative to $\mathcal{U}_{\text{phys}}$ unless a universal ending postulate is separately adopted.

15.2 Optional Universal Eventual Identity Ending

Postulate 15.1 (Optional Universal Eventual Identity Ending (UEIE)). If the optional UEIE lifecycle module is adopted, every qualified realized physical-system identity has an ending and a nonempty strict pre-ending identity history:

$$\boxed{\text{UEIE} \iff \forall A \in \mathcal{U}_{\text{phys}} \exists e_A \in I_A [\text{End}_A(e_A) \wedge \exists r_A \in I_A (r_A \prec_C e_A)]}. \quad (268)$$

UEIE concerns identity-bounded physical histories, not the extent of the cosmic stage domain. It does not follow from CMA or UCC, does not imply that the cosmic succession ends, and does not require an ending system to produce a successor.

UEIE is an optional lifecycle postulate, not a governing requirement of the foundational temporal, CMA, and UCC core. It is adopted only in a model or application that explicitly assumes universal eventual ending. Its universal quantifier ranges only over the governing ontic physical-system domain $\mathcal{U}_{\text{phys}}$ and therefore over numerical physical-system identities. It does not quantify over the cosmic physical totality $\mathcal{U}_{\text{C}}^{\text{phys}}$, which is not a member of $\mathcal{U}_{\text{phys}}$, nor does it retype physical factors as system identities. It therefore carries an independent physical lifecycle burden: arbitrary mathematical subsystems, merely convenient decompositions, or entities not admitted to $\mathcal{U}_{\text{phys}}$ are not silently included. Its adoption must not be inferred from UCC, CRP, non-termination, or from the mere availability of an identity decomposition. Empirical application of UEIE to a declared system class also presupposes a domain-specific numerical-identity criterion adequate to determine formation, persistence, and ending for that class; V38/F18 does not supply one universal empirical identity criterion for all physical-system classes.

It is not derived from:

$$\left\{ \begin{array}{c} T_{\text{ITOF}}, \text{ StrictTotalOrder}, \text{ NonTerminatingCosmicSuccession}_{\text{C}}(\mathcal{S}_{\text{C}}^{\text{tot}}, \prec_{\text{C}}), \\ \text{CSPP}, \text{ CMA}, \text{ CRP}, \text{ AFB} \end{array} \right\}. \quad (269)$$

In particular:

$$\text{CMA} \not\Rightarrow \text{UEIE}, \quad \text{UCC} \not\Rightarrow \text{UEIE}. \quad (270)$$

UEIE requires a nonempty strict pre-ending identity history:

$$\text{UEIE} \implies \forall A \in \mathcal{U}_{\text{phys}}, \quad I_A^{<e_A} \neq \emptyset. \quad (271)$$

UEIE does not by itself determine a metric lifetime, a number of realized stages, a universal ending mechanism, a universal ending threshold, or a universal ending magnitude.

15.3 Identity Cardinality under Non-Termination

The following result is mathematical and conditional. If the complete cosmic succession is additionally assumed to be non-terminating and UEIE is adopted for every identity in the governing physical-system totality, then the total number of distinct numerical physical-system identities across the complete succession cannot be finite. In the notation $|X| = \infty$ used here, ∞ means only that X is infinite; no particular infinite cardinal or countability assumption is implied.

Proposition 15.2 (Conditional infinite identity totality).

$$\left. \begin{array}{l} \text{TemporalExtensionAdmissible}_{\text{C}}(\mathcal{S}_{\text{C}}^{\text{tot}}, \prec_{\text{C}}), \\ \text{NonTerminatingCosmicSuccession}_{\text{C}}(\mathcal{S}_{\text{C}}^{\text{tot}}, \prec_{\text{C}}), \quad \text{UEIE} \end{array} \right\} \vdash |\mathcal{U}_{\text{phys}}| = \infty. \quad (272)$$

Proof. Because $\mathcal{S}_{\text{C}}^{\text{tot}} \neq \emptyset$, choose $s_0 \in \mathcal{S}_{\text{C}}^{\text{tot}}$. By the CSPP consequence of temporal admissibility, at least one qualified physical-system identity is realized at s_0 . Assume for contradiction that $\mathcal{U}_{\text{phys}}$ is finite. UEIE supplies an ending member $e_A \in I_A$ for every $A \in \mathcal{U}_{\text{phys}}$. The finite

nonempty set

$$E := \{e_A \mid A \in \mathcal{U}_{\text{phys}}\} \quad (273)$$

has a greatest member $e_\star$ under the strict total order. Conditional non-termination supplies $t \in \mathcal{S}_C^{\text{tot}}$ with $e_\star \prec_C t$. Temporal stage semantics gives some physical-system identity B realized at t . Its UEIE ending member $e_B \in E$ cannot be later than $e_\star$, so $e_B \prec_C t$, contradicting realization of B at t after its identity ending. Hence $\mathcal{U}_{\text{phys}}$ is infinite under the stated premises.

The result is not an unconditional prediction that the actual cosmic physical totality has an infinite system-identity component. The non-termination premise is an open cosmological condition in V38/F18, and UEIE is a separately declared lifecycle postulate. Nor does the result assert infinitely many simultaneously realized systems at any stage. Its exact content is

$$\begin{aligned} & \text{TemporalExtensionAdmissible}_C \wedge \text{NonTerminatingCosmicSuccession}_C \wedge \text{UEIE} \\ & \implies |\mathcal{U}_{\text{phys}}| = \infty. \end{aligned} \quad (274)$$

Application-level counting inside a selected class or granularity still requires an independently fixed physically warranted qualification and identity criterion; the theorem itself concerns the governing ontic totality quantified by UEIE.

15.4 Direct successor relation

Identity ending does not by itself entail production of a new numerical physical-system identity. A direct successor is admitted only where the ending transformation independently warrants formation of a genuinely new numerical identity. Define:

$$\text{SuccAt}(A, B; e) \iff \text{End}_A(e) \wedge A \neq B \wedge f_B = e \wedge \text{PhysicalProductionLink}(A, B; e). \quad (275)$$

The relation therefore requires:

- (i) actual ending of A ;
- (ii) numerical distinction between predecessor and successor;
- (iii) formation of B at the same common cosmic stage e ; and
- (iv) an independently warranted physical-production relation linking the ending transformation of A to formation of B .

A pre-existing qualified system does not become a direct successor merely by receiving matter or energy, absorbing constituents, interacting with the ending system, or remaining realized after that ending. In particular, if B is already realized before e and retains its numerical identity while incorporating material or other physical contributions from A , then $f_B \prec_C e$ and B is not a direct successor of A under Eq. (275). Absorption can therefore terminate A without producing any new qualified identity.

15.5 Conditional Successors and No Universal Closure

Define the direct successor family by

$$\mathfrak{S}^+(A, e) := \{B \in \mathcal{U}_{\text{phys}} \mid \text{SuccAt}(A, B; e)\}. \quad (276)$$

No universal nonemptiness condition is imposed:

$$\text{End}_A(e) \not\Rightarrow \mathfrak{S}^+(A, e) \neq \emptyset. \quad (277)$$

Accordingly, an ending transformation may physically produce no new qualified identity, one direct successor, or a plurality of direct successors. Which case obtains is fixed by independently warranted physical production and numerical identity criteria. Failure of one proposed successor candidate says nothing about other candidates; absence of every direct successor is admissible when no new identity is physically produced.

15.6 Successor identity is new even under state resemblance

Every $B \in \mathfrak{S}^+(A, e)$ is numerically distinct from A . This remains true even if a declared cross-system comparison regards the successor's formation state as physically equal or equivalent to a state of A realized before its ending. Here $\text{StateEquivalent}_\Gamma$ denotes only a declared, physically warranted cross-system state-comparison relation under criterion Γ ; it is not an identity relation. For any $r \in I_A$ with $r \prec_C e$,

$$\text{SuccAt}(A, B; e) \wedge \text{StateEquivalent}_\Gamma(X_B(e), X_A(r)) \implies A \neq B. \quad (278)$$

The same conclusion holds for resemblance in composition, organization, function, location, records, or naming. State resemblance is therefore a cross-identity physical comparison; it does not restore the ended numerical identity.

15.7 Successor history remains numerically distinct

Where $\text{SuccAt}(A, B; e)$, the successor forms at $f_B = e$, has its own identity range

$$I_B = \{s \in \mathcal{S}_C^{\text{tot}} \mid \text{ExistsAs}(B, s)\}, \quad (279)$$

and, under UCC, its own physical-history representation

$$\mathcal{H}_B = (I_B, \prec_C|_{I_B}, X_B, \Delta_B^{\text{phys}}). \quad (280)$$

Thus

$$\text{SuccAt}(A, B; e) \implies A \neq B, \quad \text{SuccAt}(A, B; e) \not\Rightarrow \mathcal{H}_B = \mathcal{H}_A. \quad (281)$$

Physical production links predecessor and successor causally without merging their numerical identities or histories.

15.8 Successor attribution and cosmic extent remain distinct

Conditional successor production does not supply a no-greatest-stage commitment. Whether an ending has zero, one, or several direct successors is an identity-production question at that ending transformation. Whether every admitted cosmic stage has a later member is the separate optional cosmological condition $\text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C)$. Neither identity ending nor direct-successor attribution, separately or together, establishes that condition.

16. Population Change Across Cosmic Order

16.1 Population-level extension

V36/F16 provides a complete stage-relative qualified population:

$$\mathcal{S}_{\text{phys}}(s). \quad (282)$$

It also provides identity-realization ranges:

$$I_A. \quad (283)$$

V38/F18 now uses those existing objects to represent how the qualified population may differ between arbitrary ordered common cosmic change stages without introducing:

$$\left\{ \begin{array}{l} \text{AdjacentStages, MovingPopulation, PopulationTransportSubstrate,} \\ \text{OneToOneSuccessorConservationLaw, PopulationConservationLaw} \end{array} \right\}. \quad (284)$$

Let:

$$r, s \in \mathcal{S}_{\text{C}}^{\text{tot}}, \quad r \prec_{\text{C}} s. \quad (285)$$

No assumption is made that r and s are adjacent.

16.2 Endpoint-persistent population

Define:

$$\mathcal{P}_{r,s} := \{A \in \mathcal{U}_{\text{phys}} \mid r \in I_A \wedge s \in I_A\}. \quad (286)$$

Every member belongs to both endpoint populations:

$$\mathcal{P}_{r,s} = \mathcal{S}_{\text{phys}}(r) \cap \mathcal{S}_{\text{phys}}(s). \quad (287)$$

Under Identity-Realization Convexity:

$$A \in \mathcal{P}_{r,s} \wedge r \prec_{\text{C}} u \prec_{\text{C}} s \implies u \in I_A. \quad (288)$$

Thus endpoint persistence implies realization of the same numerical identity at every intermediate common cosmic change stage.

This is an order-theoretic identity result, not a metric continuity claim.

16.3 Later-endpoint entrant population

Define:

$$\mathcal{N}_{r \rightarrow s} := \{A \in \mathcal{U}_{\text{phys}} \mid r \notin I_A \wedge s \in I_A\}. \quad (289)$$

The term *entrant* or *later-endpoint entrant* is population-relative. It does not mean that a system is created by time or transported into the cosmic extension.

Under AFB and Identity-Realization Convexity:

$$A \in \mathcal{N}_{r \rightarrow s} \implies r \prec_C f_A \vee f_A = s. \quad (290)$$

Since $f_A \in I_A$ and $s \in I_A$, the least-member property also gives:

$$A \in \mathcal{N}_{r \rightarrow s} \implies \neg(s \prec_C f_A). \quad (291)$$

Thus formation occurs after r and no later than s , without requiring identification of a stage immediately following r .

16.4 Earlier-endpoint departing population

Define:

$$\mathcal{L}_{r \rightarrow s} := \{A \in \mathcal{U}_{\text{phys}} \mid r \in I_A \wedge s \notin I_A\}. \quad (292)$$

Again, *departing* is population-relative. It does not mean that the system moves outside time or leaves the cosmic extension.

If optional UEIE is adopted together with Identity-Realization Convexity and $A \in \mathcal{L}_{r \rightarrow s}$, its ending member must occur before s .

Thus:

$$\{\text{UEIE}, \text{IdentityRealizationConvexity}\} \wedge A \in \mathcal{L}_{r \rightarrow s} \implies e_A \prec_C s. \quad (293)$$

Because $r \in I_A$ and $e_A \in I_A$, strict ordering and ending uniqueness permit:

$$r = e_A \quad \text{or} \quad r \prec_C e_A. \quad (294)$$

No metric lifetime is inferred.

16.5 Endpoint population decomposition

The later endpoint population decomposes exactly as:

$$\mathcal{S}_{\text{phys}}(s) = \mathcal{P}_{r,s} \dot{\cup} \mathcal{N}_{r \rightarrow s}. \quad (295)$$

The earlier endpoint population decomposes exactly as:

$$\mathcal{S}_{\text{phys}}(r) = \mathcal{P}_{r,s} \dot{\cup} \mathcal{L}_{r \rightarrow s}. \quad (296)$$

Here $\dot{\cup}$ denotes disjoint union.

The decompositions follow directly from identity-domain membership and do not assert any physical conservation equation.

In particular:

$$|\mathcal{S}_{\text{phys}}(r)| - |\mathcal{L}_{r \rightarrow s}| + |\mathcal{N}_{r \rightarrow s}| = |\mathcal{S}_{\text{phys}}(s)| \quad (297)$$

is not adopted as a universal numerical law without the additional assumptions required for the relevant cardinal arithmetic and finite-population context.

The set decompositions, not a scalar population equation, are fundamental here.

16.6 Intermediate-only identities

Endpoint comparison does not capture every numerical physical-system identity realized between r and s .

Define:

$$\mathcal{T}_{r,s} := \{A \in \mathcal{U}_{\text{phys}} \mid r \notin I_A \wedge s \notin I_A \wedge \exists u \in I_A (r \prec_C u \prec_C s)\}. \quad (298)$$

Members of $\mathcal{T}_{r,s}$ are absent from both endpoint populations while possessing a realized identity history somewhere strictly between the two endpoints.

Therefore:

$$\mathcal{T}_{r,s} \cap (\mathcal{S}_{\text{phys}}(r) \cup \mathcal{S}_{\text{phys}}(s)) = \emptyset. \quad (299)$$

This class is essential for a logically complete population comparison.

Without it, a pairwise comparison of endpoint populations could incorrectly suggest that no system formed and ended between r and s .

16.7 Formation and ending of intermediate-only identities

Under AFB and Identity-Realization Convexity, every $A \in \mathcal{T}_{r,s}$ has its formation boundary strictly between the selected endpoints. Because f_A is the least member of I_A , at least one member of I_A lies strictly between r and s , while both endpoints are absent from I_A . Hence:

$$\{\text{AFB}, \text{IdentityRealizationConvexity}\} \wedge A \in \mathcal{T}_{r,s} \implies r \prec_C f_A \prec_C s. \quad (300)$$

If UEIE is also adopted, its strict pre-ending-history requirement, together with AFB and Identity-Realization Convexity, places both formation and ending strictly between the selected endpoints:

$$\{\text{AFB}, \text{UEIE}, \text{IdentityRealizationConvexity}\} \wedge A \in \mathcal{T}_{r,s} \implies r \prec_C f_A \prec_C e_A \prec_C s. \quad (301)$$

Thus an identity may be physically formed, undergo its own UCC-governed development, and end entirely between two arbitrarily selected endpoint stages.

16.8 Population-transition representation

Define the pairwise population-transition descriptor:

$$\mathfrak{P}_C^{\text{pop}}(r, s) := (\mathcal{S}_{\text{phys}}(r), \mathcal{P}_{r,s}, \mathcal{N}_{r \rightarrow s}, \mathcal{L}_{r \rightarrow s}, \mathcal{T}_{r,s}, \mathcal{S}_{\text{phys}}(s)), \quad r \prec_C s. \quad (302)$$

This is a defined representation:

$$\text{Status}(\mathfrak{P}_C^{\text{pop}}(r, s)) = \text{DefinedPopulationMembershipProfile}. \quad (303)$$

It does not represent a moving population, a flow of time, a temporal transport mechanism, or a universal successor chain. The descriptor compares identity-domain membership across two ordered common cosmic change stages.

16.9 Population transformation does not alter temporal identity

Population change may be extensive:

$$\mathcal{S}_{\text{phys}}(r) \neq \mathcal{S}_{\text{phys}}(s). \quad (304)$$

Population difference does not generate stage-specific temporal extensions:

$$\mathcal{S}_{\text{phys}}(r) \neq \mathcal{S}_{\text{phys}}(s) \not\Rightarrow \text{DifferentTemporalExtensions}(r, s). \quad (305)$$

The one temporal referent remains Eq. (10).

Population transformation belongs to the physical histories realized within that extension.

16.10 Population transformation and complete physical realization

The endpoint profiles $\mathfrak{R}_C(r)$ and $\mathfrak{R}_C(s)$ are indexed by their respective complete then-realized qualified populations. If $\mathcal{S}_{\text{phys}}(r) \neq \mathcal{S}_{\text{phys}}(s)$, their profile domains differ.

No universal deterministic profile-to-profile map is implied. Therefore:

$$r \prec_C s \not\Rightarrow \exists F_{\text{univ}} : \mathfrak{R}_C(s) = F_{\text{univ}}(\mathfrak{R}_C(r)). \quad (306)$$

The invariant cosmic ordering fixes earlier and later.

It does not itself supply one universal physical dynamics.

Physical comparison maps, mathematical-form-neutral dynamics, operational metrics, clocks, observation, signal access, and model-to-record bridges therefore remain downstream physical or representational constructions whose parameters and outputs are type-distinct from time.

17. Cross-System Physical Comparison

17.1 Comparison requires an independently declared common space

Let $A, B \in \mathcal{S}_{\text{phys}}(s)$ in a governing realization satisfying UCC. Then both system-specific change-content terms are well typed:

$$\Delta_A^{\text{phys}}(s) \in \Xi_A, \quad \Delta_B^{\text{phys}}(s) \in \Xi_B, \quad (307)$$

without requiring

$$\Xi_A = \Xi_B. \quad (308)$$

Consequently, a mathematical comparison between the physical-change contents of distinct systems is not automatically well typed.

For a declared comparison protocol P , let

$$\mathcal{V}_{AB,P} \quad (309)$$

be a comparison space whose physical interpretation, units or normalization, domain of validity, and uncertainty structure are explicitly declared.

Introduce independently supplied maps

$$\phi_{A \rightarrow AB}^P : \Xi_A \longrightarrow \mathcal{Y}_{AB,P}, \quad (310)$$

$$\phi_{B \rightarrow AB}^P : \Xi_B \longrightarrow \mathcal{Y}_{AB,P}. \quad (311)$$

Only after these maps are physically and mathematically warranted may mapped change contents be compared within the common comparison space.

17.2 Mapped comparison is not physical identity

Define:

$$\text{MappedChange}_{A|AB,P}(s) := \phi_{A \rightarrow AB}^P \left(\Delta_A^{\text{phys}}(s) \right) \quad (312)$$

and similarly

$$\text{MappedChange}_{B|AB,P}(s) := \phi_{B \rightarrow AB}^P \left(\Delta_B^{\text{phys}}(s) \right). \quad (313)$$

Even if:

$$\text{MappedChange}_{A|AB,P}(s) = \text{MappedChange}_{B|AB,P}(s), \quad (314)$$

it does not follow that:

$$\text{MappedChange}_{A|AB,P}(s) = \text{MappedChange}_{B|AB,P}(s) \not\Rightarrow \Delta_A^{\text{phys}}(s) \equiv_{\text{type}} \Delta_B^{\text{phys}}(s). \quad (315)$$

Mapped equality is equality under the declared comparison representation.

It is not physical system identity.

17.3 General comparison operator

Let:

$$\Psi_{AB,P} : \mathcal{Y}_{AB,P} \times \mathcal{Y}_{AB,P} \longrightarrow \mathcal{Z}_{AB,P} \quad (316)$$

be a declared comparison operator.

Define:

$$\begin{aligned} \text{Cmp}_{AB,P}(s) := \Psi_{AB,P} \Big(& \phi_{A \rightarrow AB}^P(\Delta_A^{\text{phys}}(s)), \\ & \phi_{B \rightarrow AB}^P(\Delta_B^{\text{phys}}(s)) \Big). \end{aligned} \quad (317)$$

The output belongs to the comparison codomain:

$$\text{Cmp}_{AB,P}(s) \in \mathcal{Z}_{AB,P}. \quad (318)$$

It is not:

$$\text{Cmp}_{AB,P}(s) \not\equiv_{\text{type}} T_{\text{TOF}}. \quad (319)$$

This excludes any identification of the comparison output with time.

Nor is it:

$$\text{Cmp}_{AB,P}(s) \not\equiv_{\text{type}} s. \quad (320)$$

These two exclusions state that a comparison output is an application-level quantity, neither time nor a cosmic-stage member.

17.4 Admissibility of a physical comparison

A comparison is scientifically admissible only where its construction is independently specified.
Define:

$$\begin{aligned}
\text{AdmissibleComparison}(A, B; P) \implies & \text{PhysicalTargetDeclared}(A, B; P) \\
& \wedge \text{ComparisonMapsDeclared}(A, B; P) \\
& \wedge \text{ComparisonCodomainDeclared}(P) \\
& \wedge \text{UnitsOrNormalizationDeclared}(P) \\
& \wedge \text{ParameterProvenanceDeclared}(P) \\
& \wedge \text{UncertaintyStructureDeclared}(P) \\
& \wedge \text{DomainOfValidityDeclared}(P).
\end{aligned} \tag{321}$$

The condition is methodological.

It does not state that every pair of systems must admit a physically meaningful comparison.

Thus:

$$A, B \in \mathcal{S}_{\text{phys}}(s) \not\Rightarrow \exists P \text{ AdmissibleComparison}(A, B; P). \tag{322}$$

Shared membership in $\mathcal{S}_{\text{phys}}(s)$ identifies the represented population at that member of the formal cosmic-stage domain; neither population membership, CMA common-stage co-presence, nor UCC supplies quantitative comparability by itself.

17.5 No universal scalar amount of change

V38/F18 does not infer:

$$\exists \mu_{\Delta} : \bigcup_{A \in \mathcal{U}_{\text{phys}}} \Xi_A \longrightarrow \mathbb{R} \tag{323}$$

as a foundational requirement.

Accordingly:

$$\text{UCC} \not\Rightarrow \text{UniversalScalarAmountOfChange}. \tag{324}$$

The complete-population physical-realization architecture likewise supplies no universal cross-system ranking of change.

Statements such as

$$\text{“}A \text{ changed more than } B\text{”} \tag{325}$$

require a declared comparison construction.

They do not follow from the cosmic ordering itself.

17.6 Cross-level comparison under hierarchical composition

If:

$$A \triangleleft_{\kappa, s} B, \tag{326}$$

a comparison between constituent and composite change remains subject to the same mapping discipline.

Thus:

$$A \triangleleft_{\kappa,s} B \nRightarrow \text{Cmp}_{AB,P}(s) \text{ is defined.} \quad (327)$$

A physical composition model may independently supply the necessary maps.

Composition itself does not.

18. Physical Dynamics and Temporal Order

18.1 Foundational neutrality toward the form of physical dynamics

The temporal definition:

$$T_{\text{ITOF}} = (\mathcal{S}_C^{\text{tot}}, \prec_C) \quad (328)$$

does not select one universal mathematical form for physical dynamics.

No single deterministic, stochastic, quantum, field-theoretic, Hamiltonian, or relativistic-geometrical form is imposed as the universal dynamics of all physical systems. The neutrality asserted here concerns mathematical form and representation; it does not suspend CRP or the framework's declared physical-causal ontology. The foundational temporal architecture and application-level physical dynamics remain distinct. Accordingly, governing CMA remains type-distinct from every application-level physical-dynamics descriptor:

$$\text{CMA} \not\equiv_{\text{type}} \mathfrak{D}\eta\mathfrak{n}_{M;\mathcal{A}}. \quad (329)$$

The left-hand side states CMA's objective common-stage co-presence commitment within the one-global-stage architecture; the right-hand side specifies a declared physical model. Complete qualified-system actual-change coverage belongs separately to UCC. Neither common-stage co-presence nor physical-change coverage is supplied by this type-nonidentity statement. Neither side supplies a dynamical law for time.

18.2 Admissible physical-dynamics descriptor

For a declared physical-system class $\mathcal{A}$, let application model M possess the internal physical-dynamics descriptor

$$\mathfrak{D}\eta\mathfrak{n}_{M;\mathcal{A}} := (\mathcal{Z}_M, \Theta_M, \mathcal{L}_M, D_M, \text{Sol}_M). \quad (330)$$

Here $\mathcal{Z}_M$ is the declared space or class of model realizations, Θ_M the model-parameter family, $\mathcal{L}_M$ the declared physical law, evolution relation, stochastic rule, Hamiltonian structure, field equation, constraint family, or other governing model structure, D_M the physical and mathematical domain of validity, and Sol_M the declared solution or admissible-realization rule. Physical encoding and measurement are excluded from this descriptor because they belong to separately typed bridge layers.

A mathematical-form-neutral solution family may be written schematically as

$$\text{Sol}_M(D_M, \Theta_M) := \{z \in \mathcal{Z}_M(D_M) \mid \text{LawSatisfied}_M(z; \mathcal{L}_M, \Theta_M, D_M)\}. \quad (331)$$

Here LawSatisfied_M is the satisfaction predicate induced by the declared governing structure $\mathcal{L}_M$ on the stated parameter family and validity domain. This notation does not require every model to share the same mathematical ontology or to be representable as a deterministic differential

equation.

18.3 Admissibility condition

A physical model may enter an ITOF application only where its role is explicit.

Admissibility requires the following declared conditions:

$$\begin{aligned}
\text{AdmissiblePhysicalModel}(M; \mathcal{A}) \implies & \text{PhysicalTargetDeclared}(M; \mathcal{A}) \\
& \wedge \text{ModelRealizationSpaceTyped}(M) \\
& \wedge \text{PhysicalSystemBoundariesDeclared}(M) \\
& \wedge \text{IdentityCriterionDeclaredWhereApplicable}(M) \\
& \wedge \text{ParameterProvenanceDeclared}(M) \\
& \wedge \text{DynamicsFormDeclared}(M) \\
& \wedge \text{SolutionRuleDeclared}(M) \\
& \wedge \text{ModelInputBridgeDeclared}(M) \\
& \wedge \text{ModelOutputBridgeDeclared}(M) \\
& \wedge \text{DomainOfValidityDeclared}(M) \\
& \wedge \text{ApproximationStatusDeclared}(M) \\
& \wedge \text{ObservationBridgeDeclaredWhereNeeded}(M).
\end{aligned} \tag{332}$$

These are necessary methodological conditions for admission of the declared model into an ITOF application; they are not claimed to be universally sufficient for every possible physical-model class.

It does not convert the chosen dynamics into a foundational ITOF axiom.

18.4 Model evolution parameters

A model may employ one or more parameters that index mathematical evolution, solution families, record order, path position, iteration, phase, or another representation.

Let:

$$\lambda_M \tag{333}$$

be such a parameter.

Then:

$$\text{ModelEvolutionParameter}(\lambda_M; M) \not\Rightarrow \lambda_M \equiv_{\text{type}} T_{\text{ITOF}}. \tag{334}$$

Even where:

$$\lambda_M \mapsto X_A^M(\lambda_M) \tag{335}$$

accurately predicts physical records, the parameter remains a model parameter.

Thus:

$$\begin{aligned} & \text{ModelEvolutionParameter}(\lambda_M; M) \\ & \wedge \text{OperationalSuccess}_{P,M,D}(\lambda_M) \\ & \not\Rightarrow \lambda_M \equiv_{\text{type}} T_{\text{ITOF}}. \end{aligned} \quad (336)$$

18.5 Model Parameter Is Not a Cosmic-Stage Index

No global numerical map $\iota : \mathcal{S}_C^{\text{tot}} \rightarrow \mathbb{R}$ is required by the temporal definition. An application may introduce an index only with an independently declared representational role. Therefore:

$$\text{ModelEvolutionParameter}(\lambda_M; M) \not\Rightarrow \text{ExactCommonCosmicChangeStageIndex}(\lambda_M). \quad (337)$$

A model may parameterize a reconstructed or predicted physical history without enumerating the members of $\mathcal{S}_C^{\text{tot}}$.

18.6 Physical Laws and Non-Causal Time

The mathematical-form-neutral requirement is that a declared realization $z \in \mathcal{Z}_M$ satisfy the independently specified governing rule:

$$\text{LawSatisfied}_M(z; \mathcal{L}_M, \Theta_M, D_M). \quad (338)$$

A residual equation such as $\mathcal{L}_M(\mathcal{V}_M, \Theta_M) = 0$ is one admissible special case, not the universal form of physical dynamics. The physical interpretation belongs to the declared systems, fields, interactions, constraints, and physical quantities represented by the particular model.

The occurrence of an evolution parameter in the equation does not make the parameter a causal source.

Thus:

$$\text{AppearsAsEvolutionParameter}(\lambda_M) \not\Rightarrow \text{PhysicalCause}(\lambda_M). \quad (339)$$

Likewise, time is not a member of the physical causal-source domain:

$$T_{\text{ITOF}} \not\equiv_{\text{type}} \text{PhysicalCausalContributor}. \quad (340)$$

18.7 Model-to-history association

An application may associate a model trajectory, state family, stochastic family, field configuration, or other mathematical object with part of a physical-system history.

Represent that association by:

$$\Psi_{M,A}^{\text{hist}} : \text{Sol}_M(D_M, \Theta_M) \longrightarrow \mathcal{H}_A^M. \quad (341)$$

where $\mathcal{H}_A^M$ denotes only the model-represented aspects of the physical history of A . The source is the declared family of model realizations, not the domain-of-validity statement itself.

The existence of such an association alone does not establish complete representational identity:

$$\left[\Psi_{M,A}^{\text{hist}} : \text{Sol}_M(D_M, \Theta_M) \longrightarrow \mathcal{H}_A^M \right] \not\Rightarrow \mathcal{H}_A^M = \mathcal{H}_A. \quad (342)$$

Equality would require an independent argument for complete representational adequacy over every component relevant to the claim. Likewise,

$$\left[\Psi_{M,A}^{\text{hist}} : \text{Sol}_M(D_M, \Theta_M) \longrightarrow \mathcal{H}_A^M \right] \not\Rightarrow \lambda_M \equiv_{\text{type}} T_{\text{ITOF}}. \quad (343)$$

18.8 Valid Models Need Not Share One Parameter

Two physical models may successfully represent different aspects of the same physical system or different systems:

$$M_1, \quad M_2. \quad (344)$$

Their parameters may satisfy:

$$\lambda_{M_1} \neq \lambda_{M_2}. \quad (345)$$

Distinct model parameters do not imply distinct temporal referents:

$$\lambda_{M_1} \neq \lambda_{M_2} \not\Rightarrow \text{DistinctTemporalReferents}(M_1, M_2). \quad (346)$$

It indicates different representational constructions.

18.9 Formal reversibility does not reverse cosmic ordering

A physical model may admit:

$$\lambda_M \mapsto -\lambda_M. \quad (347)$$

This mathematical transformation does not reverse:

$$\prec_C. \quad (348)$$

Therefore:

$$\text{ModelInvariantUnder}(\lambda_M \mapsto -\lambda_M) \not\Rightarrow \text{CosmicOrderingReversed}. \quad (349)$$

Mathematical reversibility, physical recurrence, and non-reversal of the governing cosmic order remain distinct.

18.10 System-specific physical directionalities

A physical-system history may exhibit a directional pattern relative to a declared physical criterion without generating an additional temporal order. For qualified system A and criterion α , let

$$Y_{A,\alpha} : I_A \longrightarrow \mathcal{Y}_{A,\alpha} \quad (350)$$

be a declared physical or model-supported descriptor, and let

$$\preccurlyeq_{A,\alpha} \subseteq \mathcal{Y}_{A,\alpha} \times \mathcal{Y}_{A,\alpha} \quad (351)$$

be the comparison relation warranted for that criterion. No totality, metric, linearity, or universal cross-system meaning is assumed for $\preccurlyeq_{A,\alpha}$.

Define the criterion-indexed directionality descriptor:

$$\mathfrak{A}_{A,\alpha} := (\mathcal{Y}_{A,\alpha}, Y_{A,\alpha}, \preceq_{A,\alpha}). \quad (352)$$

For $J \subseteq I_A$, define alignment with the universal cosmic ordering on that domain by:

$$\text{ArrowAligned}_{A,\alpha}(J) \iff \forall r, s \in J, \quad r \prec_C s \implies Y_{A,\alpha}(r) \preceq_{A,\alpha} Y_{A,\alpha}(s). \quad (353)$$

Where the strict part of the criterion relation is needed, define:

$$u \prec_{A,\alpha}^{\text{phys}} v \iff u \preceq_{A,\alpha} v \wedge \neg (v \preceq_{A,\alpha} u). \quad (354)$$

A criterion-relative reversal over an ordered pair may then be represented by:

$$\text{CriterionReversal}_{A,\alpha}(r, s) \iff r \prec_C s \wedge Y_{A,\alpha}(s) \prec_{A,\alpha}^{\text{phys}} Y_{A,\alpha}(r). \quad (355)$$

Such a reversal concerns the selected physical criterion. It does not reverse the cosmic order:

$$\text{CriterionReversal}_{A,\alpha}(r, s) \not\Rightarrow s \prec_C r. \quad (356)$$

A conventional physical “arrow” is therefore admissible only as a criterion-indexed physical regularity:

$$\text{PhysicalArrow}_{A,\alpha}(J) \iff \text{ArrowAligned}_{A,\alpha}(J). \quad (357)$$

The designation is not a second meaning of time. The physical comparison relation and the universal cosmic order have different types:

$$\preceq_{A,\alpha} \not\equiv_{\text{type}} \prec_C. \quad (358)$$

Even perfect alignment over a declared domain does not transfer temporal identity:

$$\text{PhysicalArrow}_{A,\alpha}(J) \not\Rightarrow \preceq_{A,\alpha} \equiv_{\text{type}} \prec_C. \quad (359)$$

UCC requires actual system-specific physical change; it does not require one criterion to be monotonic for every system:

$$\text{UCC} \not\Rightarrow \exists \alpha \forall A \in \mathcal{U}_{\text{phys}}, \quad \text{PhysicalArrow}_{A,\alpha}(I_A). \quad (360)$$

Nor does a physical arrow require a metric on the identity range:

$$\text{PhysicalArrow}_{A,\alpha}(J) \not\Rightarrow \text{MetricOn}(J). \quad (361)$$

Thermodynamic, developmental, decay-statistical, memory- or record-related, computational, and other physical directionalities may be represented through $\mathfrak{A}_{A,\alpha}$ when the relevant physical model supplies a defined criterion and evidential support. Different directionalities may align, recur, plateau, or reverse relative to their own criteria while the universal earlier–later ordering remains fixed. The directionality descriptor is a defined application-level construction, not a new foundational temporal postulate.

19. Operational Metrics and Time

19.1 Operational metric layer

V38/F18 moves beyond the statement that a clock output is not time.

It asks how numerical quantities conventionally used to represent:

$$\begin{aligned} & \text{duration, elapsed units, frequency ratios, rates,} \\ & \text{synchronization differences, path-dependent intervals, and related metric outputs} \end{aligned} \quad (362)$$

are physically or mathematically constructed.

The governing answer is that such quantities require declared physical records, model quantities, calibration structures, comparison rules, or combinations of those ingredients.

They are not extracted as a metric already contained in $(\mathcal{S}_C^{\text{tot}}, \prec_C)$.

19.2 Non-Metricity as a Type Boundary

V38/F18 does not claim that bare earlier–later order generates differential equations, Hamiltonians, stochastic kernels, clock-response laws, or numerical intervals. Those belong to independently warranted physical-model layers. The connection to quantitative practice is instead typed: physical inputs are encoded into a declared model, the model dynamics constrain or generate admissible realizations, predicted physical quantities are mapped to records, and an operational construction maps those records together with calibration and comparison information to numerical outputs. Thus the absence of a canonical metric in T_{ITOF} is not repaired by silently inserting one into the temporal definition; quantitative scale enters only through the declared physical and operational architecture.

Accordingly,

$$\text{TemporalDefinition}_{\text{ITOF}} \not\Rightarrow \text{DynamicsDescriptorSpecified}(M; \mathcal{A}). \quad (363)$$

and successful application dynamics do not convert their evolution parameter or metric output into time.

Operational metric denotes a protocol-defined quantitative output used to express an interval, rate, ratio, synchronization difference, or related metric quantity. The term does not by itself assert that $\mathcal{Y}_P$ or $\mathcal{M}_P^{\text{op}}$ satisfies the axioms of a metric space. Where a genuine metric-space distance is required, non-negativity, separation, symmetry, the triangle inequality, the applicable domain, and the physical interpretation must be supplied independently.

19.3 General operational metric map

Let:

$$\mathfrak{R}_P \quad (364)$$

be a declared physical record domain associated with protocol P .

Let:

$$\mathcal{K}_P \quad (365)$$

contain the calibration, reference, normalization, unit, alignment, and comparison information

required by the declared operational construction.

Define:

$$\mathcal{M}_P^{\text{op}} : \mathfrak{R}_P^n \times \mathcal{K}_P \longrightarrow \mathcal{Y}_P. \quad (366)$$

For records:

$$r_1, \dots, r_n \in \mathfrak{R}_P \quad (367)$$

and declared calibration bundle $\kappa_P \in \mathcal{K}_P$, define:

$$m_P := \mathcal{M}_P^{\text{op}}(r_1, \dots, r_n; \kappa_P). \quad (368)$$

The output:

$$m_P \in \mathcal{Y}_P \quad (369)$$

is an operational quantity.

It is not time:

$$m_P \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (370)$$

19.4 Operational metric output is not an order magnitude

The ordered pair

$$(\mathcal{S}_C^{\text{tot}}, \prec_C) \quad (371)$$

contains no foundationally defined numerical distance function. This is the application-level consequence of the order-representation non-metricity result in Eq. (37). A map of the form $d_C : \mathcal{S}_C^{\text{tot}} \times \mathcal{S}_C^{\text{tot}} \rightarrow \mathbb{R}$ may be introduced only as an additional mathematical or physical-model construction; it is not part of the definition of time.

Accordingly, an operational metric output does not by itself define a magnitude on the cosmic-stage order:

$$\text{OperationalMetricOutput}(m_P) \not\Rightarrow \text{CosmicStageSeparationMagnitudeDefined}(m_P). \quad (372)$$

A numerical difference between records belongs to the declared operational scale.

19.5 Model-derived metric quantities

Some scientifically useful metric quantities are obtained primarily from a mathematical or physical model rather than directly from record arithmetic.

Let:

$$\mu_M = \mathcal{G}_M(\mathcal{V}_M, \Theta_M) \quad (373)$$

be such a model-derived metric quantity.

Then:

$$\mu_M \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (374)$$

Where:

$$m_P \approx K_{P,M}(\mu_M) \quad (375)$$

successfully connects model quantity and operational output, the agreement warrants the declared

quantitative association.

It does not establish:

$$m_P \approx K_{P,M}(\mu_M) \not\approx \mu_M \equiv_{\text{type}} T_{\text{ITOF}}. \quad (376)$$

19.6 Operational interval

For two ordered records r_1, r_2 , let:

$$N_P : \mathfrak{R}_P \longrightarrow \mathbb{R}_P \quad (377)$$

be a declared numerical reading map.

Define:

$$\Delta N_P := N_P(r_2) - N_P(r_1). \quad (378)$$

The quantity may conventionally be described as elapsed time or duration.

Within ITOF it remains:

$$\Delta N_P \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (379)$$

Nor does a numerical interval establish an exact count of common cosmic stages. From $\Delta N_P = n$ alone, no finite cardinality of intervening or endpoint common stages follows. V38/F18 supplies no stage-count function, adjacency rule, or independently warranted stage-identification-and-counting procedure from the bare strict order $(\mathcal{S}_C^{\text{tot}}, \prec_C)$. This Non-Transfer statement is kept in prose rather than introducing an otherwise unused stage-count predicate.

19.7 Operational physical rate

For measured physical quantity Q_A , define:

$$\Delta_P Q_A := \hat{Q}_{A;P,M}(r_{A,2}) - \hat{Q}_{A;P,M}(r_{A,1}). \quad (380)$$

Where:

$$\Delta N_P \neq 0, \quad (381)$$

define:

$$\bar{v}_{Q_A|N}^P := \frac{\Delta_P Q_A}{\Delta N_P}. \quad (382)$$

This is a relation between a measured physical difference and a declared operational numerical interval.

It is not:

$$\bar{v}_{Q_A|N}^P \not\equiv_{\text{type}} \text{RateOfTime}. \quad (383)$$

19.8 Operational synchronization

Let two physical standard systems produce mapped outputs:

$$n_1, \quad n_2. \quad (384)$$

Define:

$$d_{12}^P := \Gamma_{1,P}(n_1) - \Gamma_{2,P}(n_2). \quad (385)$$

For declared synchronization tolerance $\varepsilon_{\text{sync}}$:

$$\text{Synchronized}_{P, \varepsilon_{\text{sync}}}(1, 2) \iff |d_{12}^P| \leq \varepsilon_{\text{sync}}. \quad (386)$$

This is an operational relation.

It neither creates nor defines CMA:

$$\text{Synchronized}_{P, \varepsilon_{\text{sync}}}(1, 2) \not\Rightarrow \text{CMA}. \quad (387)$$

Nor does failure of synchronization negate CMA:

$$\neg \text{Synchronized}_{P, \varepsilon_{\text{sync}}}(1, 2) \not\Rightarrow \neg \text{CMA}. \quad (388)$$

Clock-output agreement and common cosmic-stage unity remain different claims.

20. Signals, Records, and Observation

20.1 Physical actuality and observational access

A system-specific physical change may be actual whether or not it is accessible to a declared observer or apparatus.

For physical manifestation χ , record r , protocol P , model M , and threshold ε :

$$\text{PairwiseTypeDistinct} \left(\text{PhysReal}_A^+(s), \text{ManifestationAt}(A, \chi; s), \text{Detected}_{P, M, \varepsilon}(A, \chi; r) \right). \quad (389)$$

Hence:

$$\text{PhysReal}_A^+(s) \not\Rightarrow \text{Detected}_{P, M, \varepsilon}(A, \chi; r). \quad (390)$$

And:

$$\neg \text{Detected}_{P, M, \varepsilon}(A, \chi; r) \not\Rightarrow \text{NC}_A^{\text{phys}}(s). \quad (391)$$

20.2 Access Relations and Common-Stage Realization

For $A, B \in \mathcal{S}_{\text{phys}}(s)$, CMA supplies objective common-stage co-presence. Under the independent UCC postulate, $\text{PhysReal}_A^+(s)$ and $\text{PhysReal}_B^+(s)$ also hold. The physical relations of interaction, signal accessibility, and observational accessibility remain separately typed:

$$\text{PhysicalInteraction}(A, B; s), \quad (392)$$

$$\text{SignalAccessible}(A, B; s), \quad (393)$$

and:

$$\text{ObservationallyAccessible}_{P, M}(B; A, s). \quad (394)$$

The first two non-entailments are fixed in Eqs. (72) and (73). Observational accessibility is likewise not supplied by CMA:

$$\text{CMA} \not\Rightarrow \forall s \in \mathcal{S}_C^{\text{tot}} \forall A, B \in \mathcal{S}_{\text{phys}}(s), \quad \text{ObservationallyAccessible}_{P, M}(B; A, s). \quad (395)$$

20.3 Signal delay does not divide the common cosmic change stage

If a signal originating from system B is not yet physically received by system A at s , this does not imply that B is absent from the common stage.

Thus:

$$A, B \in \mathcal{S}_{\text{phys}}(s) \wedge \text{SignalNotYetReceived}(A, B; s) \not\Rightarrow B \notin \mathcal{S}_{\text{phys}}(s). \quad (396)$$

Under UCC, delayed reception leaves system-specific change intact:

$$\text{UCC} \wedge A, B \in \mathcal{S}_{\text{phys}}(s) \wedge \text{SignalNotYetReceived}(A, B; s) \implies \text{PhysReal}_B^+(s). \quad (397)$$

Spatial and causal accessibility affect physical interaction and knowledge.

They do not partition the common cosmic change stage.

20.4 Observation remains physical

An observational arrangement consists of physical systems and physically realized factors.

Let:

$$\mathcal{L}_P \quad (398)$$

denote the declared family of target, apparatus, detector, record-bearing, observer, reference, calibration, communication, processing, and environmental systems entering protocol P .

For every member of that physical-system family that is realized at s , UCC gives

$$\text{UCC} \wedge X \in \mathcal{L}_P \cap \mathcal{S}_{\text{phys}}(s) \implies \text{PhysReal}_X^+(s). \quad (399)$$

A sample or target, apparatus, detector, record-bearing system, observer, and laboratory, where each satisfies the governing physical-system criteria, are therefore all inside the same changing physical domain. A laboratory may itself be a qualified composite system while its constituents retain their own qualified histories. Selection of any of these systems as a reference, standard, or observer does not exempt it from UCC.

Thus no sample, observer, apparatus, or laboratory supplies a changeless standpoint outside the common cosmic extension.

20.5 Source-to-record physical chain

A physical observation may be schematically represented by:

$$\begin{aligned} \text{SourceManifestation} &\rightsquigarrow_{\text{phys}} \text{AccessiblePhysicalEffect} \\ &\rightsquigarrow_{\text{phys}} \text{ApparatusDetectorInteraction} \\ &\rightsquigarrow_{\text{phys}} \text{RecordFormation} \\ &\rightsquigarrow_{\text{phys}} \text{PhysicalRecordAccess}. \end{aligned} \quad (400)$$

The physical links are changes and interactions of systems within the same cosmic succession; none is an operation performed from outside that succession. The source, apparatus, record-bearing system, observer, and relevant laboratory or environmental systems may contribute at different members of $\mathcal{S}_C^{\text{tot}}$, as represented by the physical support set below.

A subsequent operational reading and scientific inference may be represented by

$$\text{PhysicalRecordAccess} \longrightarrow \text{Reading} \longrightarrow \text{RestrictedScientificConclusion} . \quad (401)$$

The availability and access of a record are physical; numerical representation and scientific inference add model-dependent and inferential operations. No arrow or physical arrow in these chains denotes identity of source, record, stage, reading, or time.

20.6 Record type

For physical record r :

$$r \not\equiv_{\text{type}} \text{SourceManifestation} . \quad (402)$$

Also:

$$r \not\equiv_{\text{type}} s . \quad (403)$$

And:

$$r \not\equiv_{\text{type}} T_{\text{ITOF}} . \quad (404)$$

A record may physically encode information about a source.

Information carriage does not erase the type distinction between:

$$\text{source}, \quad \text{record}, \quad \text{stage}, \quad \text{time} . \quad (405)$$

20.7 Physical acquisition support

For record $r \in \mathfrak{R}_P$, define:

$$J_r^{\text{phys}} := \left\{ s \in \mathcal{S}_C^{\text{tot}} \mid \exists X \in \mathcal{L}_P \text{ PhysicalContributionToRecord}(X, s; r) \right\} . \quad (406)$$

A physically produced record satisfies:

$$\text{PhysicallyProducedRecord}(r) \implies J_r^{\text{phys}} \neq \emptyset . \quad (407)$$

The support need not be a singleton:

$$\left| J_r^{\text{phys}} \right| > 1 \quad (408)$$

is admissible.

Therefore:

$$\text{ReadableAt}(r; s_d) \not\Rightarrow J_r^{\text{phys}} = \{s_d\} . \quad (409)$$

20.8 Observation as a physically restricted projection

Let:

$$\mathfrak{A}_C^{P,M} \subseteq \left\{ \mathfrak{R}_C(s) \mid s \in \mathcal{S}_C^{\text{tot}} \right\} \quad (410)$$

denote only the physically accessible part of the common-stage physical-realization architecture relevant to protocol P and model M .

Define schematically:

$$\mathcal{O}_{P,M} : \mathfrak{A}_C^{P,M} \times \Theta_{P,M} \longrightarrow \mathfrak{R}_P. \quad (411)$$

Here $\Theta_{P,M}$ denotes the declared physical acquisition, transformation, calibration, and record-production conditions.

The definition of the observation map does not entail injectivity, observational completeness, or invertibility to exact common cosmic change stages. Let $\text{ObservationMapSpecified}_{P,M}$ denote that the declared map is well defined for the stated protocol and model. Then:

$$\text{ObservationMapSpecified}_{P,M} \not\Rightarrow \text{Injective}(\mathcal{O}_{P,M}), \quad (412)$$

$$\text{ObservationMapSpecified}_{P,M} \not\Rightarrow \text{SurjectiveOntoCompletePhysicalReality}(\mathcal{O}_{P,M}). \quad (413)$$

Thus:

$$\text{ObservationMapSpecified}_{P,M} \not\Rightarrow \text{RecordToExactCosmicChangeStageInverse}. \quad (414)$$

This construction formalizes the distinction between ontological population completeness and physically restricted observational access.

21. Exact-Stage Restraint

21.1 Stage designation and epistemic identification

Each admitted $s \in \mathcal{S}_C^{\text{tot}}$ is a formal stage expression of realized physical change within the common cosmic earlier–later succession. The physical realization and the earlier–later relation are objective within the governing theory; no additional stage entity or independently existing ordering-position entity is required.

Yet:

$$s \in \mathcal{S}_C^{\text{tot}} \not\Rightarrow \text{ExactCosmicChangeStageObservationallyIdentified}(s). \quad (415)$$

The distinction is epistemic and does not make the cosmic ordering observer-dependent.

21.2 Positive observational warrant

Define:

$$\begin{aligned} \text{PositiveManifestationWitness}_{A;P,M,\varepsilon}(\chi; r) &\iff \text{Detected}_{P,M,\varepsilon}(A, \chi; r) \\ &\quad \wedge \text{ValidSystemAttribution}_{P,M}(r; A) \\ &\quad \wedge \text{PhysicalSourceRecordLink}_{P,M}(A, \chi; r) \\ &\quad \wedge \text{AcceptedDifference}_{P,M,\varepsilon}(r). \end{aligned} \quad (416)$$

Then:

$$\begin{aligned} &\text{PositiveManifestationWitness}_{A;P,M,\varepsilon}(\chi; r) \\ &\implies \text{Warrant}_{P,M} \left[\exists s \in I_A \left(\text{ManifestationAt}(A, \chi; s) \wedge \text{PhysReal}_A^+(s) \right) \right]. \end{aligned} \quad (417)$$

The existential witness is physically actual.

The record does not thereby identify which member of I_A it is. Under UCC, the investigated system continues to realize physical change at every admitted member of its identity range, while the sample, detector, apparatus, record-bearing system, observer, laboratory, and reference systems also continue to change wherever they are qualified systems. This makes first noticeability a threshold within ongoing physical change rather than its onset. The stronger claim that an exact stage member cannot be identified is not derived from UCC alone; it also depends on the source–record architecture, finite physical access, and the absence of an independently warranted unique stage-identification inverse.

21.3 Formal Exact-Change-Stage Restraint

Principle 21.1 (Exact-Change-Stage Restraint). A valid physical observation may warrant that a manifestation, physical difference, threshold crossing, recurrence, formation-related manifestation, ending-related manifestation, or ordered physical development is realized at some common cosmic change stage in a physical-system history.

The observation does not thereby identify that exact common cosmic change stage or its exact position in the complete universal ordering. The restraint is epistemic rather than ontological: the source, sample, detector, apparatus, record-bearing system, observer, laboratory, and reference systems are themselves physically changing wherever they qualify as physical systems, so no changeless external observer or record is silently introduced as a cosmic-stage label.

The positive existential warrant is already fixed by Eq. (417). The restraint concerns what that same validated witness does not identify:

$$\text{PositiveManifestationWitness}_{A;P,M,\varepsilon}(\chi; r) \not\Rightarrow \text{ExactCosmicChangeStageIdentified}_{P,M}(A, \chi), \quad (418)$$

and:

$$\text{PositiveManifestationWitness}_{A;P,M,\varepsilon}(\chi; r) \not\Rightarrow \text{ExactCosmicOrderPositionIdentified}_{P,M}(A, \chi). \quad (419)$$

21.4 Exact-stage restraint is not derived from UCC alone

The UCC condition states universal system-specific physical-change actuality and, when the systems participating in observation are qualified members of $\mathcal{U}_{\text{phys}}$, excludes treating the sample, apparatus, observer, or laboratory as a changeless external temporal anchor. It does not by itself establish observational non-identifiability.

Therefore:

$$\text{UCC} \not\Rightarrow \text{ExactChangeStageNonidentifiabilityAsLogicalTheorem}. \quad (420)$$

The restraint additionally depends on:

$$\begin{aligned} &\text{source–record separation,} \quad \text{finite physical access,} \\ &\text{absence of an external changeless measurement anchor,} \\ &\text{changing acquisition and record-bearing systems,} \\ &\text{possibly non-singleton record support,} \quad \text{model dependence,} \\ &\text{and stage–record type distinction.} \end{aligned} \quad (421)$$

21.5 First notice is not first change

Under UCC, every earlier admitted member of the same identity range already expresses actual physical change realized in that physical system:

$$\text{UCC} \wedge s \in I_A \wedge I_A^{<s} \neq \emptyset \implies \forall q \in I_A^{<s}, \quad \text{PhysReal}_A^+(q). \quad (422)$$

Let $\text{FirstResolvedManifestation}_{P,M,\varepsilon}(A, \chi; r)$ mean only that r is the earliest record in the declared protocol order that resolves manifestation χ as attributable to A above the stated criterion. It does not encode a minimum of the physical-change history. Hence

$$\begin{aligned} & \text{FirstResolvedManifestation}_{P,M,\varepsilon}(A, \chi; r) \\ & \not\Rightarrow \exists s \in I_A \left[\text{ManifestationAt}(A, \chi; s) \right. \\ & \quad \left. \wedge \forall q \in I_A (q \prec_C s \Rightarrow \neg \text{PhysReal}_A^+(q)) \right]. \end{aligned} \quad (423)$$

A detection threshold concerns the changing source–acquisition–record system and the declared criterion. It does not establish a transition from physical stasis to physical change. A resolved manifestation warrants that the relevant physical condition was realized at some common cosmic change stage, but neither the exact member of $\mathcal{S}_C^{\text{tot}}$ nor its exact position in the universal ordering is thereby identified. The first resolved observation is therefore an observational threshold event, not an ontological onset marker for change.

21.6 Record order and source-development order

Let:

$$r_1 \prec_P r_2 \quad (424)$$

be an order relation in a declared record domain.

Then:

$$r_1 \prec_P r_2 \not\Rightarrow \text{SourceDevelopmentEarlier}(A, \chi_1, \chi_2). \quad (425)$$

A physical source-order bridge is required.

Let:

$$\text{OrderBridge}_{A;P,M}(r_1, r_2; \chi_1, \chi_2) \quad (426)$$

denote such a warranted relation.

Then a record comparison may support:

$$\begin{aligned} & \text{Warrant}_{P,M} \left[\exists s_1, s_2 \in I_A : s_1 \prec_C s_2 \right. \\ & \quad \wedge \text{ManifestationAt}(A, \chi_1; s_1) \\ & \quad \left. \wedge \text{ManifestationAt}(A, \chi_2; s_2) \right]. \end{aligned} \quad (427)$$

This still does not identify the exact pair:

$$\text{Warrant}_{P,M}[\exists s_1, s_2 (\dots)] \not\Rightarrow \text{ExactCosmicChangeStagePairIdentified}_{P,M}(A, \chi_1, \chi_2). \quad (428)$$

22. Clocks as Physical Systems and Standards

22.1 Physical status of a clock

A clock is a physical system selected because a sufficiently reproducible, stable, controllable, or modelable part of its physical operation can generate ordered records and standardized numerical outputs. Modern atomic-clock comparisons provide high-precision physical record domains for such response analysis [12, 13, 23, 24, 25].

Thus:

$$\text{Clock}(C) \implies \text{PhysicalSystem}(C). \quad (429)$$

The clock possesses:

$$I_C = \left\{ s \in \mathcal{S}_C^{\text{tot}} \mid \text{ExistsAs}(C, s) \right\}, \quad (430)$$

and under UCC:

$$C \in \mathcal{S}_{\text{phys}}(s) \implies \text{PhysReal}_C^+(s). \quad (431)$$

Under CRP:

$$\text{PhysReal}_C^+(s) \implies \mathcal{C}_C^{\text{act}}(s) \neq \emptyset. \quad (432)$$

Selection of a physical system as a standard does not remove it from physical change or causal realization.

22.2 Clock process, record, and reading

A clock involves at least three analytically distinct levels:

$$\text{ClockProcess}, \quad \text{ClockRecord}, \quad \text{ClockReading}. \quad (433)$$

Each remains type-distinct from time:

$$\text{ClockProcess} \not\equiv_{\text{type}} T_{\text{ITOF}}, \quad (434)$$

$$\text{ClockRecord} \not\equiv_{\text{type}} T_{\text{ITOF}}, \quad (435)$$

A clock record is a physical record produced by the clock process; it is not time. and:

$$\text{ClockReading} \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (436)$$

The three objects are physical or operational parts of a clock model. None is the temporal referent T_{ITOF} .

22.3 Clock-record map

Let $J \subseteq I_C$ denote a portion of the clock's physical history relevant to record production.

Let $\Theta_{C,P}$ contain declared operating, environmental, interrogation, control, detector, transfer, and record-production conditions.

Define:

$$\mathcal{R}_{C,P} : (\mathcal{H}_C|_J, \Theta_{C,P}) \longmapsto r_C. \quad (437)$$

This map is a physical/operational construction.

It does not assign a rate to time.

22.4 Numerical clock reading

Define:

$$N_{C,P} : \mathfrak{R}_{C,P} \longrightarrow \mathbb{R}_P. \quad (438)$$

For:

$$r_C \in \mathfrak{R}_{C,P}, \quad (439)$$

the protocol assigns the numerical reading

$$n_C = N_{C,P}(r_C). \quad (440)$$

This equation defines the reading as an output of the record map; it does not identify the reading with time.

Then:

$$n_C \not\equiv_{\text{type}} r_C, \quad (441)$$

and:

$$n_C \not\equiv_{\text{type}} s, \quad n_C \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (442)$$

22.5 Clock interval as a special operational metric

For two records:

$$r_{C,1} \triangleleft_P r_{C,2}, \quad (443)$$

define:

$$\Delta N_{C,P} := N_{C,P}(r_{C,2}) - N_{C,P}(r_{C,1}). \quad (444)$$

Then:

$$\Delta N_{C,P} \not\equiv_{\text{type}} \text{MagnitudeOf} \left(\mathcal{S}_C^{\text{tot}}, \prec_C \right). \quad (445)$$

The quantity is a special case of the operational metric architecture developed in Section 19.

22.6 Clock comparison

For clocks C_1, C_2 , map their readings into a declared comparison codomain:

$$d_{12}^{\text{obs}} := \Gamma_{1,12}(N_{C_1,P_1}(r_1)) - \Gamma_{2,12}(N_{C_2,P_2}(r_2)). \quad (446)$$

A resolved:

$$d_{12}^{\text{obs}} \neq 0 \quad (447)$$

warrants a physical/operational difference under the declared comparison conditions.

It does not establish:

$$d_{12}^{\text{obs}} \neq 0 \not\Rightarrow \text{DifferentCosmicExtensions}(C_1, C_2). \quad (448)$$

Nor:

$$d_{12}^{\text{obs}} \neq 0 \not\Rightarrow \text{CosmicOrderingDeformed} . \quad (449)$$

Nor:

$$d_{12}^{\text{obs}} \neq 0 \not\Rightarrow \text{DifferentRatesOfTime}(C_1, C_2) . \quad (450)$$

22.7 Clock Synchronization and Global-Stage Co-Presence

Clock synchronization remains operational:

$$\text{Synchronized}_{P,\varepsilon}(C_1, C_2) . \quad (451)$$

The one-global-stage architecture supplies the common formal cosmic-stage domain. CMA independently states objective collective co-presence:

$$\text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s) . \quad (452)$$

Their distinction is:

$$\text{Synchronized}_{P,\varepsilon} \not\equiv_{\text{type}} \text{CosmicCoPresence}_C . \quad (453)$$

Common-stage unity is not constructed by clock agreement.

22.8 Clock failure

Functional clock failure need not terminate numerical identity:

$$\text{ClockFailure}_P(C; s) \not\Rightarrow \text{End}_C(s) . \quad (454)$$

If:

$$s \in I_C , \quad (455)$$

then under UCC:

$$\text{ClockFailure}_P(C; s) \wedge s \in I_C \implies \text{PhysReal}_C^+(s) . \quad (456)$$

Likewise:

$$\text{NoClockOutputAfter}_P(C; s) \not\Rightarrow \text{CosmicSuccessionStopsAt}(s) . \quad (457)$$

23. Physical Response and Records

23.1 From clock response to typed application

V36/F16 developed clock-response modeling as an application-level construction. V38/F18 generalizes the same discipline to arbitrary admissible physical-system classes without promoting any application model into the temporal core. In this application vocabulary, a physical or operational “response” is a predicted or measured characterization of a realized or model-predicted physical effect; it is not a foundational intermediate entity between cause and change.

The governing typed chain is Eq. (103). For a declared system A , its independently warranted physical conditions, causal contributors, boundaries, and preparations enter the physical-input

domain; the model-input bridge encodes them, the declared dynamical rule constrains or generates admissible model realizations according to its stated mathematical type, the model-output bridge yields predicted physical quantities, and the measurement bridge connects those quantities to records. Every step requires an independently specified relation of the correct type. No step is supplied by the definition of time, CMA, or UCC alone.

23.2 Application-level status

The distinction is:

$$\text{TemporalTypeClaim} \not\equiv_{\text{def}} \text{PhysicalResponseModel}. \quad (458)$$

And:

$$\text{SuccessfulPhysicalPrediction} \not\Rightarrow \text{ModelOutput} \equiv_{\text{type}} T_{\text{ITOF}}. \quad (459)$$

23.3 Physical-condition bundle

For system A_i and accepted comparison index k , let:

$$\mathcal{B}_{i,k} := \left(\hat{X}_{i,k}, \hat{Z}_{i,k}, \hat{R}_{i,k}, \hat{\Pi}_{i,k} \right), \quad (460)$$

where:

- (i) $\hat{X}_{i,k}$ is the reconstructed system state relevant to the declared model;
- (ii) $\hat{Z}_{i,k}$ is the declared local or environmental physical-condition bundle;
- (iii) $\hat{R}_{i,k}$ contains relevant physical relations to other systems or reference structures;
- (iv) $\hat{\Pi}_{i,k}$ contains applicable physical propagation, transfer, interaction- path, or comparison-path conditions that belong to the declared model-input specification. Acquisition, calibration, and record-alignment conditions belong to the separately typed measurement layer.

Additional model-specific variables may be introduced only where physically required.

No component is automatically a coordinate of $\mathcal{S}_C^{\text{tot}}$.

23.4 Physical response function

Let:

$$\hat{q}_{i,k}^M = \mathcal{Q}_{i,M}(\mathcal{B}_{i,k}; \theta_i) \quad (461)$$

be a predicted physical or operational response. Where atomic or optical physical-system models are used, independently derived sensitivity calculations can supply application-level coefficient provenance when physically warranted [26].

The model parameters:

$$\theta_i = (\theta_{i,1}, \dots, \theta_{i,p_i}) \quad (462)$$

must possess declared provenance:

$$\text{Prov}(\theta_{i,j}) = \mathcal{P}_{i,j}. \quad (463)$$

Admissible provenance may include:

$$\begin{aligned} & \text{independent physical derivation, independent measurement,} \\ & \text{construction specification, independent calibration,} \\ & \text{external physical constraint, or declared derivation-domain estimation.} \end{aligned} \tag{464}$$

23.5 Benchmark recovery is not independent prediction

If:

$$\text{Prov}(\theta) = \text{BenchmarkAssigned}, \tag{465}$$

then:

$$\text{Prov}(\theta) = \text{BenchmarkAssigned} \not\Rightarrow \text{IndependentPrediction}(\theta). \tag{466}$$

Likewise:

$$\theta = \Theta(D_{\text{eval}}) \not\Rightarrow \text{IndependentPrediction}(D_{\text{eval}}). \tag{467}$$

A model may successfully recover an existing benchmark.

Recovery and advance prediction remain distinct inferential statuses.

24. Predeclared Physical Tests

24.1 Four inferential levels

V38/F18 retains the hierarchy:

$$\text{Recovery} \longrightarrow \text{AdvancePrediction} \longrightarrow \text{ModelDiscrimination} \longrightarrow \text{FoundationalAssessment}. \tag{468}$$

The arrows indicate increasing inferential burden.

They do not state automatic entailment.

Recovery concerns whether a declared application model represents known records adequately within a specified domain.

Advance prediction requires model form, parameter values or derivation rules, controls, uncertainty, and acceptance criteria to be fixed independently before the evaluation outcome is known.

Model discrimination requires sufficiently separated rival predictions.

Foundational assessment additionally requires identifiable logical attribution to the foundational commitments under test.

24.2 Protocol freeze

Let:

$$\mathfrak{P}^* := (\mathcal{S}, \mathcal{B}, \mathcal{Q}, \mathfrak{M}, \Theta, \mathcal{C}, \Sigma, \mathcal{E}, \mathcal{A}, \mathcal{F}, \mathcal{R}). \tag{469}$$

The components specify:

- (i) physical systems and system classes;

- (ii) physical-system boundaries and identity criteria;
- (iii) controlled and measured physical-condition bundles;
- (iv) application model and declared rival models;
- (v) model form and parameter provenance;
- (vi) positive and null-control channels;
- (vii) covariance, uncertainty, and bounded remainder structure;
- (viii) exclusions and data-quality rules;
- (ix) acceptance criteria;
- (x) failure criteria;
- (xi) replication specification.

Predictive status requires:

$$\text{ProtocolFrozen}(\mathfrak{P}^*) \implies \text{NoEvaluationOutcomeDependence}(\mathfrak{P}^*). \quad (470)$$

For any application whose claims depend on numerical physical-system identity, the system class, declared system boundary, and applicable identity criterion are part of the frozen protocol rather than post-evaluation interpretive choices:

$$\begin{aligned} & \text{ProtocolFrozen}(\mathfrak{P}^*) \wedge \text{IdentitySensitiveApplication}(\mathfrak{P}^*) \\ & \implies \text{OutcomeIndependentSystemClass}(\mathfrak{P}^*) \\ & \quad \wedge \text{OutcomeIndependentSystemBoundary}(\mathfrak{P}^*) \\ & \quad \wedge \text{OutcomeIndependentIdentityCriterion}(\mathfrak{P}^*). \end{aligned} \quad (471)$$

Where formation, ending, or successor attribution is part of the tested claim, the corresponding formation, ending, and successor criteria must likewise be declared before evaluation. A post-evaluation revision of any such criterion is a revised protocol, not a retroactive rescue of the original test:

$$\text{PostEvaluationIdentityOrBoundaryRevision} \not\Rightarrow \text{OriginalProtocolPredictionSucceeded}. \quad (472)$$

The revised identity or boundary specification requires independent evaluation under a newly declared protocol. This constraint does not impose one universal identity criterion on all physical-system classes; it prevents outcome-dependent reclassification within a specific test.

24.3 Derivation and evaluation separation

Let:

$$D_{\text{der}} \quad (473)$$

be the derivation domain and:

$$D_{\text{eval}} \quad (474)$$

the evaluation domain.

Require:

$$D_{\text{der}} \cap D_{\text{eval}} = \emptyset. \quad (475)$$

But:

$$D_{\text{der}} \cap D_{\text{eval}} = \emptyset \not\Rightarrow \text{NoEvaluationLeakage}. \quad (476)$$

Outcome-sensitive model form, preprocessing, exclusions, covariance choices, thresholds, controls, remainder bounds, or model-selection rules can still produce leakage despite record-level separation.

24.4 Prediction separation

For rival models M_1, M_2 , let:

$$\hat{\mathbf{y}}^{M_1}, \quad \hat{\mathbf{y}}^{M_2} \quad (477)$$

be their predeclared evaluation predictions.

Define:

$$\Delta \hat{\mathbf{y}}_{12} := \hat{\mathbf{y}}^{M_1} - \hat{\mathbf{y}}^{M_2}. \quad (478)$$

A meaningful discrimination claim requires that the predicted separation be resolved relative to the declared combined uncertainty structure. Using the short predicate $\text{ResolvedSep}_{\Sigma_{12}}$ for that declared criterion:

$$\text{PredictionSeparation}(M_1, M_2; P, D) \implies \text{ResolvedSep}_{\Sigma_{12}}(\Delta \hat{\mathbf{y}}_{12}). \quad (479)$$

No universal numerical threshold is imposed by the foundation.

The criterion belongs to the predeclared protocol.

24.5 Identifiability

A fitted model does not acquire predictive force merely because one parameter choice reproduces the observations.

Let:

$$\mathbf{J}_D = \left[\frac{\partial \hat{y}_k^M}{\partial \theta_j} \right]_{k \in D} \quad (480)$$

be the local sensitivity matrix.

For positive-definite covariance:

$$\mathbf{W}_D^T \mathbf{W}_D = \Sigma_D^{-1}, \quad (481)$$

define:

$$\mathbf{X}_D = \mathbf{W}_D \mathbf{J}_D. \quad (482)$$

A local identifiability criterion may require:

$$\text{Identifiable}_D(M) \iff \text{rank}(\mathbf{X}_D) = p_M \wedge \kappa_2(\mathbf{X}_D) \leq \kappa_{\max}, \quad (483)$$

where the conditioning bound is declared before evaluation.

This is an application-level statistical criterion.

It is not part of the definition of time.

25. Foundation-to-Observable Bridges

25.1 Foundational and Empirical Bridges Differ

The local stage-change condition remains:

$$\text{StageChangeBridge}_C(s). \quad (484)$$

It records the local conjunction of CMA common-stage co-presence and UCC complete system-specific actual-change coverage at member s . It is a foundational representation only and is not an empirical bridge.

A foundational empirical bridge instead records the additional physical and observational premises required to derive a measurable consequence.

Therefore:

$$\text{StageChangeBridge}_C \not\equiv_{\text{type}} \text{FoundationalEmpiricalBridge}. \quad (485)$$

The distinction is central to V38/F18.

25.2 Empirical bridge tuple

For foundational claim F , protocol P , and evaluation domain D , with any declared application-model family represented within B_F^{phys} by its physical-encoding, dynamical, and model-to-prediction premises, define the full empirical assessment tuple by:

$$\mathfrak{B}_F^{P,D} := (B_F^{\text{phys}}, B_F^{\text{obs}}, \mathcal{P}_F^{\text{aux}}, \Sigma_F, \mathcal{A}_F). \quad (486)$$

Here:

- (i) B_F^{phys} contains independently specified physical-encoding, dynamical, and model-to-prediction premises;
- (ii) B_F^{obs} contains independently specified acquisition, source-record, measurement, and reconstruction premises;
- (iii) $\mathcal{P}_F^{\text{aux}}$ contains additional independently warranted auxiliary assumptions;
- (iv) Σ_F contains the declared uncertainty and covariance architecture;
- (v) $\mathcal{A}_F$ contains the attribution conditions required to determine which premise class is actually challenged by an observed failure.

The tuple is methodological. Its first three entries refine the derivational core stated in Eq. (487); Σ_F and $\mathcal{A}_F$ govern evaluation and attribution rather than the logical content of the predicted observable itself. When B_F^{phys} , B_F^{obs} , or $\mathcal{P}_F^{\text{aux}}$ appears in a conjunction or entailment, the symbol denotes the conjunction of its declared propositional premises. The tuple $\mathfrak{B}_F^{P,D}$ itself is never used as a proposition.

It is not a physical object and not a component of time.

25.3 Foundational-to-observable derivation

A claimed observable consequence O_F must satisfy:

$$F \wedge B_F^{\text{phys}} \wedge B_F^{\text{obs}} \wedge \mathcal{P}_F^{\text{aux}} \vdash O_F. \quad (487)$$

The derivation itself must not be reconstructed after observing the outcome if advance predictive status is claimed.

Thus:

$$\text{AdvanceFoundationalPrediction} \implies \text{OutcomeIndependentSpecification} \left(\mathfrak{B}_F^{P,D}, O_F \right). \quad (488)$$

25.4 Observable Failure and Foundational Scope

If:

$$F \wedge B_F^{\text{phys}} \wedge B_F^{\text{obs}} \wedge \mathcal{P}_F^{\text{aux}} \vdash O_F \quad (489)$$

and:

$$\neg O_F, \quad (490)$$

then:

$$\neg O_F \not\Rightarrow \neg F. \quad (491)$$

The failure may instead lie in:

$$B_F^{\text{phys}}, \quad B_F^{\text{obs}}, \quad \mathcal{P}_F^{\text{aux}}, \quad \Sigma_F, \quad \text{or their declared domain.} \quad (492)$$

25.5 Foundational Attribution Principle

Principle 25.1 (Foundational Empirical Attribution Principle). A failed or successful application-level observable warrants a conclusion about a foundational commitment only where the derivational path from foundation to observable is independently specified and the attribution of the result to the foundational difference is identifiable against bridge, auxiliary, acquisition, and uncertainty alternatives.

Formally:

$$\begin{aligned} \text{FoundationalAttribution}(F; O, P, D) \implies & \text{FoundationToObservableDerivationDeclared} \\ & \wedge \text{OutcomeIndependentBridges} \\ & \wedge \text{ProtocolFrozen}(P) \\ & \wedge \text{NoEvaluationLeakage}(P, D) \\ & \wedge \text{ValidPhysicalSystemBoundaries} \\ & \wedge \text{ValidIdentityCriteriaWhereApplicable} \\ & \wedge \text{ValidAcquisitionSupport} \\ & \wedge \text{ValidCovariance} \\ & \wedge \text{PredictionSeparationIdentifiable} \\ & \wedge \text{AlternativeAttributionControlled}. \end{aligned} \quad (493)$$

These conditions are necessary.

They are not claimed to be universally sufficient for every possible experimental domain. The principle is methodological and evidential: it constrains what may be warranted from a foundation-to-observable derivation. It adds no temporal component, ontological realization commitment, physical causal law, or independent empirical postulate.

25.6 Current empirical status and foundation-specific prediction criterion

The existence of formal counterconditions to CMA, the UCC continuity condition, or other foundational commitments is distinct from the existence of a presently available finite experiment that uniquely identifies those counterconditions. Likewise, a foundational conflict with a rival temporal ontology is not by itself an experimental preference relation.

Therefore, where no independently warranted physical branch produces a resolved prediction separation attributable to the foundational difference, V38/F18 does not claim that experiment has already established empirical preference for ITOF over that rival ontology:

$$\neg \text{FoundationSpecificSeparation}_{P,D} \implies \neg \text{ExperimentalPreferenceEstablished}_{P,D}(I, R). \quad (494)$$

This is an epistemic-status statement, not a retreat from the formal contrary conditions. The current scientific burden is to construct an independently warranted physical bridge for which prediction separation and foundational attribution survive the declared uncertainty and bridge freedom.

At the present V38/F18 stage, the framework does not claim a unique quantitative observable residual derived from the temporal foundation alone. This limitation is stated explicitly because a foundation-specific prediction cannot be created by stipulation without adding prediction-relevant physical content. Any future claim of an ITOF-specific prediction must identify the responsible foundational premise, derive the physical consequence through independently warranted application physics, fix the measurement bridge before outcome-sensitive evaluation, compare the relevant rival on matched shared inputs, and show that the resulting observable separation survives uncertainty and admissible bridge freedom. A candidate effect that is merely appended as an optional interaction is a test of that interaction, not yet a test of ITOF's temporal ontology.

25.7 Foundational discrimination between two alternatives

For foundational alternatives:

$$F, \quad F^*, \quad (495)$$

a warranted discrimination claim requires independently specified observable consequences:

$$F \wedge B_F^{\text{phys}} \wedge B_F^{\text{obs}} \wedge \mathcal{P}_F^{\text{aux}} \vdash O_F, \quad (496)$$

$$F^* \wedge B_{F^*}^{\text{phys}} \wedge B_{F^*}^{\text{obs}} \wedge \mathcal{P}_{F^*}^{\text{aux}} \vdash O_{F^*}. \quad (497)$$

A necessary condition is:

$$\begin{aligned}
& \text{Warrant}_{P,D} [\text{FoundationalDiscrimination}(F, F^*)] \\
& \implies \text{OutcomeIndependentSpecification} \left(\mathfrak{B}_F^{P,D}, \mathfrak{B}_{F^*}^{P,D} \right) \\
& \quad \wedge \text{ProtocolFrozen}(P) \\
& \quad \wedge \text{NoEvaluationLeakage}(P, D) \\
& \quad \wedge \text{PredictionSeparationBeyondCombinedUncertainty} (O_F, O_{F^*}; P, D) \\
& \quad \wedge \text{FoundationalAttributionIdentifiable} (F, F^*; P, D) .
\end{aligned} \tag{498}$$

Shared calibrations or systematic inputs are not prohibited where their dependence is explicitly represented in provenance and covariance.

25.8 Application-model vs foundational discrimination

If two application models differ:

$$M_1 \neq M_2, \tag{499}$$

and observation favours one:

$$\text{DiscriminationFavours}(M_1), \tag{500}$$

the warranted conclusion is initially:

$$\text{Warrant} [\text{ApplicationModelSupportedOn}(M_1; D)] . \tag{501}$$

It does not automatically follow that:

$$\text{DiscriminationFavours}(M_1) \not\Rightarrow \text{FoundationalTheoryEstablished} . \tag{502}$$

Application models may differ for reasons downstream of their foundations.

25.9 No post-hoc immunity

Suppose model M_1 makes a predeclared advance prediction and fails.

A later model:

$$M_2 \tag{503}$$

may legitimately introduce a newly established physical contributor, improved response law, corrected boundary condition, or revised uncertainty structure.

That scientific revision does not alter the historical status of the original test:

$$\text{PostEvaluationRevision}(M_1 \rightarrow M_2) \not\Rightarrow \text{OriginalAdvancePredictionSucceeded} . \tag{504}$$

The revised model requires:

$$M_2 \longrightarrow D_{\text{new}} \tag{505}$$

for new predictive evaluation.

This prevents unrestricted auxiliary modification from making an application model empirically

immune to failure.

25.10 Direct UCC countercondition

The direct physical contrary to UCC is equivalently:

$$\exists A \in \mathcal{U}_{\text{phys}} \exists s \in I_A, \quad \text{NC}_A^{\text{phys}}(s). \quad (506)$$

By Eq. (81), this is exactly the condition $\exists A \in \mathcal{U}_{\text{phys}} \exists s \in I_A : \neg \text{PhysReal}_A^+(s)$.

A null difference:

$$D^{\text{obs}} = 0 \quad (507)$$

does not establish that contrary:

$$D^{\text{obs}} = 0 \not\Rightarrow \exists A \in \mathcal{U}_{\text{phys}} \exists s \in I_A, \quad \text{NC}_A^{\text{phys}}(s). \quad (508)$$

Positive physical warrant for $\text{NC}_A^{\text{phys}}(s)$ of the qualified persisting system at an admitted stage would be required. A zero selected-variable result, criterion-relative stability, or failure to resolve change is not the same proposition.

25.11 CMA challenge condition

The governing contrary to CMA is failure of objective common-stage co-presence of the complete then-realized qualified population at an admitted stage. Complete physical non-change of a realized qualified system is instead the direct contrary to UCC.

Different physical states, different clock outputs, spatial separation, delayed signals, or different observational access do not themselves establish either kind of challenge.

Thus:

$$\text{DifferentPhysicalOutputs}(A, B) \not\Rightarrow \neg \text{CMA}. \quad (509)$$

Likewise:

$$\text{SignalDelay}(A, B) \not\Rightarrow \neg \text{CMA}. \quad (510)$$

A challenge to CMA must address objective common-stage co-presence. A challenge to UCC must establish complete physical non-change of at least one realized qualified system at an admitted member. These evidential targets are distinct.

25.12 Strong test condition

A strong discriminating application satisfies:

$$\begin{aligned}
\text{StrongDiscriminatingTest} \implies & \text{ProtocolFrozen} \\
& \wedge \text{IndependentPhysicalBridge} \\
& \wedge \text{IndependentParameterProvenance} \\
& \wedge \text{ValidPhysicalSystemBoundaries} \\
& \wedge \text{ValidAcquisitionSupport} \\
& \wedge \text{ValidCovariance} \\
& \wedge \text{NoEvaluationLeakage} \\
& \wedge \text{IdentifiableModel} \\
& \wedge \text{PositiveDiscriminatingChannels} \\
& \wedge \text{NullControlChannels} \\
& \wedge \text{RivalPredictionSeparation} \\
& \wedge \text{IndependentEvaluation} .
\end{aligned} \tag{511}$$

Where replication is physically appropriate and claimed:

$$\text{IndependentReplication} \tag{512}$$

is added as a further condition.

25.13 Scientific claim boundary

The formal existence of a foundational contrary and the existence of a direct finite experimental procedure are different propositions.

Thus:

$$\text{FormalCountercondition}(F) \not\equiv_{\text{def}} \text{DirectFiniteExperimentFor}(F). \tag{513}$$

Similarly:

$$\text{FinitePositiveObservations} \not\Rightarrow \text{DeductiveConfirmationOfUniversalCommitment} . \tag{514}$$

This restraint applies to UCC and other universal commitments.

The absence of a simple finite direct test does not remove their formal contrary conditions.

Conversely, the existence of a formal contrary does not by itself prove that current experimental practice can identify that contrary without additional physical characterization.

26. Application Bridge Structure

26.1 Five distinct levels

The V38/F18 bridge architecture consists of five distinct levels without collapsing their roles.

$$\begin{aligned}
&\text{Level I: } \text{FoundationalCommitment}, \\
&\text{Level II: } \text{FoundationalDefinedRepresentation}, \\
&\text{Level III: } \text{PhysicalEncodingDynamicsAndPrediction}, \\
&\text{Level IV: } \text{MeasurementAndRecordBridge}, \\
&\text{Level V: } \text{EmpiricalComparisonAndAttribution}.
\end{aligned} \tag{515}$$

For example:

$$\text{CMA} \wedge \text{UCC} \implies \forall s \in \mathcal{S}_C^{\text{tot}} \text{ StageChangeBridge}_C(s). \tag{516}$$

belongs to the foundational and defined-representation levels. The converse at each admitted stage is only the local unpacking of the defined bridge into its CMA and UCC components; the bridge is not an independent foundational commitment.

Level III is the typed physical application chain formed by the model-input bridge, the declared dynamics, and the model-output bridge in Eq. (103). Level IV begins only when predicted physical quantities enter the measurement or observation bridge and are connected to records under a declared protocol. Thus a physical response law belongs to Level III, whereas a source-record or acquisition relation belongs to Level IV.

A model-discrimination or foundational-attribution claim belongs to Level V.

26.2 No upward identity transfer

No successful lower-level construction changes the logical type of the foundation.

Thus:

$$\text{SuccessfulApplicationChain} \not\Rightarrow \text{ApplicationOutput} \equiv_{\text{type}} T_{\text{ITOF}}. \tag{517}$$

And:

$$\text{SuccessfulMeasurementBridge} \not\Rightarrow \text{Record} \equiv_{\text{type}} T_{\text{ITOF}}. \tag{518}$$

The same type boundary applies to successful measurement: a record does not become time.

Likewise:

$$\text{SuccessfulEmpiricalRecovery} \not\Rightarrow \text{ModelParameter} \equiv_{\text{type}} T_{\text{ITOF}}. \tag{519}$$

These non-transfer results are instances of the generalized Non-Transfer Principle.

26.3 No downward automatic derivation

The temporal definition $T_{\text{ITOF}} = (\mathcal{S}_C^{\text{tot}}, \prec_C)$ does not by itself determine any specific physical dynamics, clock response, metric output, signal law, observation model, or experimental prediction:

$$\text{TemporalDefinition}_{\text{ITOF}} \not\Rightarrow \text{SpecificApplicationPhysics}. \tag{520}$$

Likewise:

$$\text{CMA} \not\Rightarrow \text{SpecificClockDifference}, \quad (521)$$

and:

$$\text{UCC} \not\Rightarrow \text{SpecificNonzeroSystemDifferential}. \quad (522)$$

System specificity permits physically different responses.

It does not manufacture a quantitative difference without an independently specified physical law.

26.4 Bridge closure before external-theory confrontation

Quantitative confrontation with an external physical theory requires the dependency chain:

$$\begin{aligned} \text{FoundationalDifference} &\longrightarrow \text{IndependentlySpecifiedPhysicalBridge} \\ &\longrightarrow \text{DistinctAdvancePrediction} \\ &\longrightarrow \text{PhysicalRecord} \\ &\longrightarrow \text{ControlledComparison} \\ &\longrightarrow \text{IdentifiableAttribution}. \end{aligned} \quad (523)$$

Without the second and third steps, foundational disagreement remains foundational disagreement.

It does not become an empirical victory merely by declaration.

The generalized Non-Transfer Principle fixes the type boundary governing such external-theory comparisons.

27. Generalized Non-Transfer Principle

27.1 Scope

The Non-Transfer Principle prevents mathematical, representational, physical, and operational success from being converted into temporal identity without an independent identity argument.

V38/F18 generalizes that discipline beyond clocks and relativistic quantities.

Let q denote any mathematical, physical-model, operational, representational, geometrical, statistical, coordinate, record-derived, or comparison quantity.

Let:

$$\text{MathematicallyConsistent}_M(q) \quad (524)$$

state that q belongs to a mathematically consistent declared model M .

Let:

$$\text{OperationalSuccess}_{P,M,D}(q) \quad (525)$$

state that use of q contributes successfully to prediction, reconstruction, measurement, comparison, or calculation under protocol P , model M , and physical domain D .

Principle 27.1 (Generalized Non-Transfer Principle (NTP)). Mathematical consistency, physical applicability, and operational or predictive success do not transfer temporal identity to the object, parameter, relation, or quantity possessing those properties:

$$\boxed{\text{NTP : } \text{MathematicallyConsistent}_M(q) \wedge \text{OperationalSuccess}_{P,M,D}(q) \not\Rightarrow q \equiv_{\text{type}} T_{\text{ITOF}}.} \quad (526)$$

The principle protects the governing definition in Eq. (10).

27.2 Three separate transfers are prohibited

V38/F18 distinguishes three logically different transfer errors.

First:

$$\text{MathematicallyConsistent}_M(q) \not\Rightarrow \text{ActuallyPhysicallyRealized}(q). \quad (527)$$

Second:

$$\text{ActuallyPhysicallyRealized}(q) \not\Rightarrow q \equiv_{\text{type}} T_{\text{ITOF}}. \quad (528)$$

Third:

$$\text{OperationalSuccess}_{P,M,D}(q) \not\Rightarrow q \equiv_{\text{type}} T_{\text{ITOF}}. \quad (529)$$

These statements are not one transitive argument.

They block different unjustified inferences.

A mathematical object may lack physical realization.

A physically real object may remain non-temporal.

A predictively successful quantity may remain only the quantity defined by its model or measurement procedure.

27.3 Naming does not determine type

A quantity may historically contain the word “time” in its conventional name.

That linguistic fact does not determine its ontological type:

$$\text{NameContainsTime}(q) \not\Rightarrow q \equiv_{\text{type}} T_{\text{ITOF}}. \quad (530)$$

Temporal classification depends on the construction and role of q and on an independent identity argument relative to the governing definition of T_{ITOF} . Terminological convention cannot supply that identity argument.

27.4 Model-parameter Non-Transfer

The basic model-parameter non-transfer statement is already fixed in Eq. (334). Even predictive success does not supply temporal identity:

$$\text{ModelEvolutionParameter}(\lambda_M; M) \wedge \text{OperationalSuccess}_{P,M,D}(\lambda_M) \not\Rightarrow \lambda_M \equiv_{\text{type}} T_{\text{ITOF}}. \quad (531)$$

A parameter may successfully order a solution, label model states, parameterize a path, or predict

physical records.

Those roles do not make it the universal cosmic extension.

27.5 Operational-metric Non-Transfer

For operational metric quantity m_P :

$$m_P = \mathcal{M}_P^{\text{op}}(r_1, \dots, r_n; \kappa_P) \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (532)$$

Higher precision likewise does not transfer type:

$$\text{Precision}(m_P) \rightarrow \text{VeryHigh} \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (533)$$

27.6 Coordinate Non-Transfer

For coordinate map:

$$\chi : \mathcal{E}_{\text{phys}} \longrightarrow \mathbb{R}^n, \quad (534)$$

the coordinate representation of event e is not the event:

$$e \not\equiv_{\text{type}} \chi(e). \quad (535)$$

Likewise, a coordinate component used to label model evolution remains type-distinct from time:

$$x^0 \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (536)$$

27.7 Geometrical Non-Transfer

Let:

$$(\mathcal{M}, g) \quad (537)$$

be a mathematical manifold–metric structure used in an external or application model.

Then:

$$\text{GeometricalRepresentation}(\mathcal{M}, g) \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (538)$$

Even if the geometrical model successfully predicts physical records:

$$\text{OperationalSuccess}_{P,M,D}(\mathcal{M}, g) \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (539)$$

27.8 Physical-history Non-Transfer

A physical history is not time:

$$\mathcal{H}_A \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (540)$$

The restricted ordering $\prec_C|_{I_A}$ is the order component of the physical history and does not create an independent private time. In the governing ontology:

$$\forall A \in \mathcal{U}_{\text{phys}}, \quad \neg \text{PrivateTimeOf}(A). \quad (541)$$

27.9 Physical-realization-profile Non-Transfer

The complete-population common-stage physical-realization profile remains outside the definition of time by Eq. (164).

The restriction remains necessary because V38/F18 expands the theory of physical realization.

The expanded realization architecture does not identify time with the cosmic physical totality or with any complete physical-reality profile:

$$T_{\text{ITOF}} \not\equiv_{\text{type}} \mathfrak{U}_C^{\text{phys}}, \quad T_{\text{ITOF}} \not\equiv_{\text{type}} \text{CompletePhysicalRealityProfile}. \quad (542)$$

The cosmic physical totality is physical ontology; a realization profile is a typed physical representation; time denotes the ordered extension of realized change. None is retyped as another.

The temporal architecture and the physical-realization architecture remain integrated but type-distinct.

28. Relativistic Temporal Identifications

28.1 Foundational point of disagreement

Relativistic theories possess substantial calculational and predictive success in experimentally tested physical domains [4, 5, 6, 7]. V38/F18 treats those successes as successes of the corresponding physical and geometrical models within the domains in which their empirical warrant is established; the associated foundational questions concerning time remain separate [8, 9].

This acknowledgment does not alter the foundational issue.

ITOF rejects identification of time with coordinate time, metric interval, proper-time functional, frame-dependent simultaneity relation, spacetime metric, foliation parameter, cosmological coordinate parameter, or clock output.

The disagreement concerns temporal identity.

It is therefore direct and foundational.

Two questions must remain separate:

$$\text{DoesRelativisticModelPredictPhysicalRecordsSuccessfully?} \quad (543)$$

and:

$$\text{IsRelativisticModelQuantityIdenticalWithITOFTime?} \quad (544)$$

The first is an empirical and quantitative question.

The second is definitional and ontological.

Hence:

$$\text{RelativisticPredictionSuccessful} \not\Rightarrow \text{RelativisticTemporalQuantity} \equiv_{\text{type}} T_{\text{ITOF}}. \quad (545)$$

28.2 Foliation and the common stage domain

A relativistic spacetime model may employ a foliation $\{\Sigma_\lambda\}_{\lambda \in L}$ when such a construction is independently admissible for the declared model and domain. V38/F18 does not identify any leaf Σ_λ , foliation parameter λ , coordinate-time function, or Cauchy slicing with a common cosmic change stage merely because that mathematical structure is useful. A foliation is a structure inside a declared spacetime representation. By contrast, the one-global-stage architecture fixes one cosmic-stage domain $\mathcal{S}_C^{\text{tot}}$ for all qualified physical-system identities. That common formal cosmic-stage domain does not by itself establish objective collective co-presence; CMA independently requires the complete qualified population represented at an admitted member to be objectively co-present at that same common cosmic stage. This commitment is not constructed from a foliation, coordinate chart, or synchronization convention.

Accordingly, relating a relativistic spacetime representation to ITOF cosmic-stage expressions requires an independently declared cross-representation bridge assigning the relevant physically realized manifestations to members of $\mathcal{S}_C^{\text{tot}}$. Such a bridge is not supplied by a Lorentz transformation, coordinate convention, synchronization rule, metric tensor, or foliation alone, and it is not inferred from the empirical success of those constructions. The existence of a usable foliation in a particular relativistic model therefore neither establishes the one-global-stage architecture nor turns that foliation into $\mathcal{S}_C^{\text{tot}}$. CMA is interpreted within that architecture and asserts objective common-stage co-presence. It supplies neither a spacetime-to-stage map nor a physical-change requirement; UCC separately supplies complete system-specific actual-change continuity.

This architecture does not convert ITOF into presentism. The derived reference-stage prefix introduced earlier is only an order-relative subset of the full admitted stage totality; it does not define a moving present, generated frontier, second mode of stage existence, or privileged hypersurface. Neither the one-global-stage architecture nor CMA postulates a temporal ether, rest medium, preferred inertial frame, velocity field, or material carrier.

The foundational conflict is explicit. Any relativistic ontological interpretation that denies objective frame-independent universal common-stage co-presence is formally incompatible with CMA within ITOF's one-global-stage architecture. That incompatibility concerns temporal ontology and cannot be removed by a change of coordinates or synchronization convention. Its formal source is distinct from UCC's complete actual-change burden, which requires actual physical change in every qualified physical system represented at each admitted member. Relativistic equations may nevertheless be used as independently warranted application-level physical models; their calculational or empirical success does not transfer temporal identity to a coordinate, metric quantity, proper-time functional, or spacetime foliation.

28.3 Relativistic quantity family

Let:

$$\mathcal{Q}_{\text{rel}} := \left\{ \begin{array}{l} x_F^\mu, t_F, g_{\mu\nu}, ds^2, \tau[\gamma, g], \Sigma_\lambda, \sim_F, \\ J^+(p), J^-(p), t_{\text{cos}}, t_{\text{age}}, \\ \text{ClockOutput}, \text{SynchronizationOutput} \end{array} \right\}. \quad (546)$$

These objects perform different mathematical, geometrical, physical-model, or operational roles. Their common inclusion in $\mathcal{Q}_{\text{rel}}$ does not make them one type.

The governing ITOF conclusion is:

$$\forall q \in \mathcal{Q}_{\text{rel}}, \quad q \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (547)$$

In particular:

$$t_F \not\equiv_{\text{type}} T_{\text{ITOF}}, \quad (548)$$

$$g_{\mu\nu} \not\equiv_{\text{type}} T_{\text{ITOF}}, \quad (549)$$

$$ds^2 \not\equiv_{\text{type}} T_{\text{ITOF}}, \quad (550)$$

$$\tau[\gamma, g] \not\equiv_{\text{type}} T_{\text{ITOF}}, \quad (551)$$

$$\Sigma_\lambda \not\equiv_{\text{type}} s, \quad s \in \mathcal{S}_C^{\text{tot}}, \quad (552)$$

$$\sim_F \not\equiv_{\text{type}} \text{CosmicCoPresence}_C, \quad (553)$$

$$\text{ClockOutput} \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (554)$$

No successful calculation changes these type relations.

28.4 Relativistic Non-Transfer

For $q \in \mathcal{Q}_{\text{rel}}$, the generalized Non-Transfer Principle of Eq. (526) applies without a relativistic exception.

Even physical realization of a quantity's referent does not transfer temporal identity:

$$\text{ActuallyPhysicallyRealizedReferent}(q) \not\Rightarrow q \equiv_{\text{type}} T_{\text{ITOF}}. \quad (555)$$

For example, physical gravitational systems, paths, clocks, signals, and matter distributions may be real while the mathematical metric used to represent their relations remains a model quantity.

28.5 No semantic transfer from successful terminology

The conventional use of terms such as:

$$\begin{aligned} &\text{coordinate time, proper time, time dilation, cosmic time,} \\ &\text{time coordinate, time function} \end{aligned} \quad (556)$$

does not settle the ontological question posed by ITOF.

Thus:

$$\text{StandardTerminology}(q, \text{"time"}) \not\Rightarrow q \equiv_{\text{type}} T_{\text{ITOF}}. \quad (557)$$

The ITOF classification follows the construction and role of the quantity, not its conventional label.

29. Coordinates and Temporal Invariance

29.1 Physical event and coordinate assignment

Let:

$$\mathcal{E}_{\text{phys}} \tag{558}$$

be a declared family of physically realized events or manifestations.

For chart or frame F , let:

$$\chi_F : \mathcal{E}_{\text{phys}} \longrightarrow \mathbb{R}^4. \tag{559}$$

For:

$$e \in \mathcal{E}_{\text{phys}}, \tag{560}$$

the coordinate tuple is:

$$x_F^\mu(e) = \chi_F(e). \tag{561}$$

The physical manifestation is not its coordinates:

$$e \not\equiv_{\text{type}} \chi_F(e). \tag{562}$$

Likewise:

$$\mathfrak{U}_C^{\text{phys}} \not\equiv_{\text{type}} (\mathcal{M}, g). \tag{563}$$

A spacetime manifold and metric may represent physical relations in an application model; they are not identical with the cosmic physical totality represented.

29.2 Coordinates Do Not Create Common Stages

Suppose:

$$\text{ManifestationAt}(A, \chi; s), \quad s \in I_A. \tag{564}$$

A relativistic model may assign:

$$\chi_F(e) = (x_F^0, x_F^1, x_F^2, x_F^3). \tag{565}$$

Accordingly, the coordinate component remains type-distinct from both the common cosmic-stage member and the ITOF temporal referent:

$$x_F^0 \not\equiv_{\text{type}} s. \tag{566}$$

$$x_F^0 \not\equiv_{\text{type}} T_{\text{ITOF}}. \tag{567}$$

A coordinate value may be operationally associated with a physical event. Even when a coordinate component is chosen so that its ordering agrees with $\prec_C$ on a declared domain, it remains an order representation in the sense of Eq. (36). Its numerical intervals are therefore not fixed by the bare cosmic order.

It does not become the common cosmic-stage designation or the ordering position that designation represents.

29.3 Different meanings of invariance

V38/F18 explicitly distinguishes:

$$\text{PairwiseDefDistinct}(\text{InvariantCosmicOrdering}, \text{LorentzInvariance}, \text{GeneralCovariance}). \quad (568)$$

Invariant Cosmic Ordering means that:

$$\prec_C \quad (569)$$

is the one fixed universal earlier–later ordering of the common cosmic change-stage totality.

Lorentz invariance concerns transformation properties under Lorentz transformations.

General covariance concerns admissible coordinate representation of physical laws.

Neither defines:

$$T_{\text{ITOF}}. \quad (570)$$

Therefore:

$$\text{LorentzInvariant}(q) \not\Rightarrow q \equiv_{\text{type}} T_{\text{ITOF}}, \quad (571)$$

and:

$$\text{GenerallyCovariant}(M) \not\Rightarrow \text{TimeDefinedBy}(M). \quad (572)$$

29.4 Coordinates Do Not Transform Cosmic Order

A special-relativistic transformation may contain:

$$t' = \gamma \left(t - \frac{vx}{c^2} \right), \quad \gamma = \frac{1}{\sqrt{1 - v^2/c^2}}. \quad (573)$$

The transformation relates coordinate assignments.

It does not transform:

$$\left(\mathcal{S}_C^{\text{tot}}, \prec_C \right). \quad (574)$$

Thus:

$$t \neq t' \not\Rightarrow \text{ITOFTimeTransformed}. \quad (575)$$

More generally:

$$\text{CoordinateTransform}(F \rightarrow F') \not\Rightarrow \text{Transform} \left(\mathcal{S}_C^{\text{tot}}, \prec_C \right). \quad (576)$$

Different coordinate assignments do not generate different cosmic extensions.

30. Metric Geometry and Proper Time

30.1 Metric interval

In a relativistic model:

$$ds^2 = g_{\mu\nu} dx^\mu dx^\nu. \quad (577)$$

The expression defines a geometrical model quantity under the adopted metric structure.

It is not:

$$ds^2 \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (578)$$

Nor is:

$$g_{\mu\nu} \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (579)$$

Metric success therefore does not establish temporal identity:

$$\text{MetricPredictionSuccessful} \not\Rightarrow g_{\mu\nu} \equiv_{\text{type}} T_{\text{ITOF}}. \quad (580)$$

30.2 Metric dependence on physical or coordinate variables

A metric may be represented as:

$$g_{\mu\nu} = g_{\mu\nu}(x). \quad (581)$$

It does not follow that:

$$g_{\mu\nu} = g_{\mu\nu}(x) \not\Rightarrow T_{\text{ITOF}} = T_{\text{ITOF}}(x). \quad (582)$$

ITOF does not define time as a field whose value changes from one spacetime location to another.

30.3 Curvature

General-relativistic geometry may possess:

$$R^{\rho}_{\sigma\mu\nu} \neq 0. \quad (583)$$

This geometrical result does not imply:

$$R^{\rho}_{\sigma\mu\nu} \neq 0 \not\Rightarrow \text{ITOFTimeCurved}. \quad (584)$$

The ordered pair:

$$\left(\mathcal{S}_{\text{C}}^{\text{tot}}, \prec_{\text{C}} \right) \quad (585)$$

is not assigned a curvature tensor by the definition of time.

30.4 Einstein field equation

A general-relativistic application may employ:

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}. \quad (586)$$

V38/F18 does not deny the mathematical content or empirically warranted physical use of such equations [5, 6].

The relevant type conclusion remains:

$$\text{EinsteinFieldEquationSuccessfulOn}(D) \not\Rightarrow g_{\mu\nu} \equiv_{\text{type}} T_{\text{ITOF}}. \quad (587)$$

The equation relates geometrical and matter-energy model quantities.

It does not define the ITOF temporal referent.

30.5 Proper-time functional

For timelike path γ :

$$\tau[\gamma, g] = \frac{1}{c} \int_{\gamma} \sqrt{-g_{\mu\nu} dx^{\mu} dx^{\nu}}. \quad (588)$$

The quantity depends on:

$$\gamma \quad \text{and} \quad g. \quad (589)$$

Therefore:

$$\tau = \tau[\gamma, g]. \quad (590)$$

ITOF therefore assigns the direct type relation:

$$\tau[\gamma, g] \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (591)$$

Different path-dependent values satisfy:

$$\tau[\gamma_1, g] \neq \tau[\gamma_2, g]. \quad (592)$$

That difference does not establish different temporal extensions:

$$\tau[\gamma_1, g] \neq \tau[\gamma_2, g] \not\Rightarrow \text{DistinctTemporalReferents}(\gamma_1, \gamma_2). \quad (593)$$

They establish different values of the declared metric functional.

30.6 Proper time is not a private physical-system time

For physical system A represented by a worldline or path γ_A :

$$\tau[\gamma_A, g] \quad (594)$$

is not the restriction:

$$\prec_C|_{I_A}. \quad (595)$$

Thus:

$$\tau[\gamma_A, g] \not\equiv_{\text{type}} \prec_C|_{I_A}. \quad (596)$$

Accordingly, the proper-time functional is not a private temporal extension belonging to the system:

$$\tau[\gamma_A, g] \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (597)$$

The system has a physical history within the one common cosmic ordering.

It does not possess a separate temporal extension.

30.7 Clock agreement with proper-time calculation

A physical clock output may satisfy:

$$N_{C,P} \approx K_{P,M} (\tau[\gamma, g]) \quad (598)$$

within the warranted domain of a relativistic model.

The conclusion is:

$$\text{QuantitativeAssociationSupported}(N_{C,P}, \tau[\gamma, g]). \quad (599)$$

It is not:

$$N_{C,P} \approx K_{P,M}(\tau[\gamma, g]) \not\Rightarrow \tau[\gamma, g] \equiv_{\text{type}} T_{\text{TOF}}. \quad (600)$$

The relation is therefore an example of successful model-to-record association without ontological transfer.

31. Relativity of Simultaneity, Lorentzian Structure, and Common Stages

31.1 Frame-dependent simultaneity

Let:

$$e_1 \sim_F e_2 \quad (601)$$

denote simultaneity assigned according to relativistic frame, chart, and synchronization structure F .

Different admissible frames may satisfy:

$$\exists e_1, e_2, F, F', \quad e_1 \sim_F e_2 \wedge \neg(e_1 \sim_{F'} e_2). \quad (602)$$

For the standard Lorentz transformation along one spatial axis,

$$\Delta t' = \gamma \left(\Delta t - \frac{v \Delta x}{c^2} \right). \quad (603)$$

Hence two spatially separated events satisfying $\Delta t = 0$ in one inertial coordinate system generally satisfy

$$\Delta t' = -\gamma \frac{v \Delta x}{c^2} \neq 0 \quad (604)$$

when $v \Delta x \neq 0$. V38/F18 therefore does not dispute the frame-dependence of relativistic coordinate simultaneity. The foundational issue is instead whether that representational fact exhausts the ontology of temporal ordering and co-realization.

The relation:

$$\sim_F \quad (605)$$

is a relativistic representational relation.

It is not:

$$\sim_F \not\equiv_{\text{type}} \text{CosmicCoPresence}_C. \quad (606)$$

31.2 Global-stage co-presence is not synchronization

The common formal domain of cosmic stages is constitutive of the one-global-stage architecture; clock synchronization neither creates nor replaces that formal cosmic-stage domain. Objective collective co-presence is not obtained from the formal cosmic-stage domain alone: CMA inde-

pendently requires the complete then-realized qualified population to be co-present at the same common cosmic stage. UCC separately requires each such system to realize its own physical change there. Equation (69) does not define co-presence through signal exchange, clock agreement, coordinate equality, Einstein synchronization, frame choice, or hypersurface construction.

Thus:

$$\text{SynchronizationConventionChanged} \not\Rightarrow \text{CosmicCoPresenceChanged} . \quad (607)$$

And:

$$\text{CoordinateAssignmentChanged} \not\Rightarrow \text{CommonCosmicChangeStageRealizationChanged} . \quad (608)$$

31.3 Lorentz Domain and No Temporal Ether

In a Minkowski representation a Lorentz transformation acts on spacetime coordinates or event representations, for example

$$x'^{\mu} = \Lambda^{\mu}_{\nu} x^{\nu}, \quad \Lambda^{\top} \eta \Lambda = \eta. \quad (609)$$

No ITOF rule identifies this matrix action with an action on the formal cosmic-stage domain $\mathcal{S}_C^{\text{tot}}$ or derives from it a map that replaces the governing order $\prec_C$. The Lorentz transformation changes the relativistic representation assigned to events; it does not, by type alone, transform the ITOF ordered pair. This is the domain distinction already expressed by Eq. (576).

The common-stage ontology also introduces no material or spatial ether. T_{ITOF} contains no spatial coordinate, velocity field, rest-medium variable, or dynamical substrate. The one-global-stage architecture supplies the common formal cosmic-stage domain and does not select a preferred inertial frame; objective co-realization is supplied by CMA, not by membership in the formal cosmic-stage domain alone. In particular, the framework separately establishes Eqs. (643) and (644). Any preferred-frame dynamics, measurable anisotropy, or velocity-dependent new coupling must therefore enter as an additional physical hypothesis with its own empirical burden; it is not contained in CMA or in the definition of time.

Consequently V38/F18 does not attempt to evade the foundational disagreement by recasting common-stage identity as Einstein synchronization or by introducing a hidden rest medium. It localizes the disagreement: Lorentz covariance and relativity of coordinate simultaneity remain model facts, whereas denial of every objective universal common-stage co-realization is a stronger ontological claim that conflicts directly with CMA's objective common-stage co-presence claim within the one-global-stage architecture.

31.4 Direct foundational conflict

A relativistic representation containing frame-dependent simultaneity does not by that mathematical fact alone negate the ITOF global-stage architecture or CMA.

The direct foundational conflict is exact and is not softened by coordinate terminology: any ontological interpretation that denies a frame-independent universal common cosmic-stage co-realization for the complete then-realized qualified physical-system population is incompatible with CMA's objective common-stage co-presence claim within ITOF's one-global-stage architecture. Formally, the common-stage contradiction is supplied by CMA rather than by the common formal cosmic-stage-domain background or by the bare PhysReal^+ clause. This ontological incompatibility does not by itself negate the mathematical consistency, Lorentz covariance, or

empirical success of relativistic physical models; empirical discrimination requires an independently warranted physical-to-observable difference.

Let:

$$\text{NoUniversalCommonStageOntology} \quad (610)$$

denote that stronger claim.

Then the conflict is with CMA within the one-global-stage architecture:

$$\left[\forall s \in \mathcal{S}_C^{\text{tot}}, \quad \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s) \right] \wedge \text{NoUniversalCommonStageOntology} \implies \perp. \quad (611)$$

Equivalently, at stage-relative level, the fixed global-stage consequence cannot coexist with its denial:

$$\left[\forall s \in \mathcal{S}_C^{\text{tot}} : \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s) \right] \wedge \left[\exists s \in \mathcal{S}_C^{\text{tot}} : \neg \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s) \right] \implies \perp. \quad (612)$$

This is a genuine foundational incompatibility of the two asserted ontologies. It is not removed by reinterpreting common-stage identity as an operational synchronization convention, because CMA is an ontological common-stage co-presence commitment within ITOF, not a clock procedure.

31.5 The conflict is not yet an empirical discriminant

Foundational contradiction does not by itself produce a measurable separation:

$$\text{FoundationalConflict} \not\Rightarrow \text{EmpiricalDiscrimination}. \quad (613)$$

Empirical discrimination requires the bridge architecture established earlier:

$$\begin{aligned} &\text{FoundationalConflict} \wedge \text{IndependentPhysicalBridges} \wedge \text{SeparatedPredictions} \\ &\quad \wedge \text{ValidObservation} \wedge \text{IdentifiableAttribution}. \end{aligned} \quad (614)$$

Conceptual disagreement alone therefore does not constitute experimental refutation.

32. Common Stages and Signal Access

Relativistic causal domains represent causal accessibility within the declared spacetime model. They remain distinct from the constitutive common-stage incidence of the global-stage architecture and from the general physical source–signal–record architecture of Section 39.

32.1 Common-stage realization is not instantaneous causation

For:

$$A, B \in \mathcal{S}_{\text{phys}}(s), \quad (615)$$

CMA gives objective common-stage co-presence for the complete stage population.

That co-realization does not give:

$$\text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s) \wedge A, B \in \mathcal{S}_{\text{phys}}(s) \not\Rightarrow \text{InstantaneousCausalInfluence}(A, B; s). \quad (616)$$

Nor:

$$\text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s) \wedge A, B \in \mathcal{S}_{\text{phys}}(s) \not\Rightarrow \text{InstantaneousSignalTransfer}(A, B; s). \quad (617)$$

Common-stage co-realization therefore does not imply instantaneous signal transfer.

Nor:

$$\text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s) \wedge A, B \in \mathcal{S}_{\text{phys}}(s) \not\Rightarrow \text{MutualObservationalAccess}(A, B; s). \quad (618)$$

These three non-implications separate common-stage co-realization from causation, signalling, and observational access.

CMA is not a hidden superluminal interaction postulate.

32.2 Relativistic causal domains

For modeled event p :

$$J^+(p), \quad J^-(p) \quad (619)$$

represent causal-accessibility domains within the adopted spacetime model.

They are not:

$$J^\pm(p) \not\equiv_{\text{type}} \mathcal{S}_C^{\text{tot}}. \quad (620)$$

Nor:

$$J^\pm(p) \not\equiv_{\text{type}} \mathcal{E}_C. \quad (621)$$

Causal accessibility and universal ordering therefore remain distinct:

$$\text{CausallyAccessible}(e_1, e_2) \not\equiv_{\text{def}} \text{CosmicallyOrdered}(e_1, e_2). \quad (622)$$

32.3 No signal requirement for common-stage membership

Let:

$$A, B \in \mathcal{S}_{\text{phys}}(s) \quad (623)$$

while:

$$\text{SignalNotYetReceived}(A, B; s). \quad (624)$$

Then:

$$\text{SignalNotYetReceived}(A, B; s) \not\Rightarrow B \notin \mathcal{S}_{\text{phys}}(s). \quad (625)$$

Under UCC and the stated common-stage membership of B , delayed reception cannot suspend B 's physical change:

$$\text{UCC} \wedge B \in \mathcal{S}_{\text{phys}}(s) \wedge \text{SignalNotYetReceived}(A, B; s) \implies \text{PhysReal}_B^+(s). \quad (626)$$

A distant system does not wait for its signal to reach another system before participating in the common cosmic change stage.

32.4 Signal propagation does not transport time

A physical signal chain:

$$\text{Emission} \rightsquigarrow_{\text{phys}} \text{Propagation} \rightsquigarrow_{\text{phys}} \text{Reception} \rightsquigarrow_{\text{phys}} \text{RecordFormation} \quad (627)$$

contains changing physical systems, fields, interactions, and records.

It does not transport:

$$T_{\text{ITOF}}. \quad (628)$$

Thus:

$$\text{SignalPropagation}(A \rightarrow B) \not\Rightarrow \text{TimeTransported}(A \rightarrow B). \quad (629)$$

A finite record delay is a physical/operational property of the signal and acquisition chain.

It is not evidence of multiple temporal extensions.

33. Foliations and Global-Stage Interpretation

33.1 Mathematical foliation

Let:

$$\mathfrak{F} = \{\Sigma_\lambda\}_{\lambda \in \Lambda} \quad (630)$$

be a mathematical foliation where such a construction is defined [6, 10].

A hypersurface:

$$\Sigma_\lambda \quad (631)$$

is not automatically a common cosmic change stage:

$$\Sigma_\lambda \not\equiv_{\text{type}} s, \quad s \in \mathcal{S}_C^{\text{tot}}. \quad (632)$$

Likewise:

$$\lambda \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (633)$$

33.2 A global time function does not establish ITOF ontology

If a mathematical or relativistic model possesses:

$$t_{\text{glob}} : \mathcal{M} \longrightarrow \mathbb{R}, \quad (634)$$

its existence does not establish:

$$\exists t_{\text{glob}} : \mathcal{M} \rightarrow \mathbb{R} \not\Rightarrow \text{ActuallyPhysicallyRealized}(\mathcal{S}_C^{\text{tot}}, \prec_C). \quad (635)$$

The model construction and ITOF temporal ontology remain different claims.

33.3 CMA does not select a unique relativistic foliation

Conversely:

$$\text{CMA} \not\Rightarrow \exists! \mathfrak{F} \text{ ExactlyRepresents } (\mathcal{S}_C^{\text{tot}}, \prec_C). \quad (636)$$

V38/F18 does not identify a coordinate foliation with the common cosmic change-stage totality.

Any proposed association

$$\Sigma_\lambda \leftrightarrow s \quad (637)$$

is an additional model-level hypothesis requiring independent physical justification; CMA does not supply that association.

33.4 Cross-representation burden and Lorentzian extra structure

Special relativity makes simultaneity of spatially separated events frame-dependent under Lorentz transformations [4, 6]. V38/F18 does not deny that result and does not derive CMA from Lorentzian geometry. To compare CMA with a relativistic spacetime $(\mathcal{M}, g)$, an application must introduce an additional association

$$\Phi_M : \mathcal{S}_C^{\text{tot}} \rightarrow \mathcal{P}(\mathcal{M}), \quad s \mapsto \Phi_M(s), \quad (638)$$

where $\Phi_M(s)$ denotes the event set, hypersurface, or other spacetime representation proposed for stage s . Neither the Lorentzian metric nor CMA alone supplies Φ_M . This is a cross-type representation bridge, not a type identity: the ITOF stage remains a member of the formal cosmic-stage domain, while its image is a geometric object inside the declared spacetime model. In particular,

$$s \not\equiv_{\text{type}} \Phi_M(s), \quad T_{\text{ITOF}} \not\equiv_{\text{type}} (\mathcal{M}, g), \quad t_F \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (639)$$

Equality of a coordinate-time label inside a chart is therefore not a definition of common-stage co-presence, and common-stage co-presence does not require equal spatial coordinates for distinct systems.

If the images $\Phi_M(s)$ are taken to form physically distinguished hypersurfaces, the application has added structure beyond the bare Lorentzian model:

$$(\mathcal{M}, g) \mapsto (\mathcal{M}, g, \Phi_M). \quad (640)$$

Globally hyperbolic spacetimes can admit smooth Cauchy foliations, but the existence of such foliations does not select one as the physically realized ITOF stage representation [10]. A physically distinguished slicing can therefore not be smuggled into the framework as a consequence of Lorentzian geometry.

The empirical burden is explicit. If observable predictions depend on the added association, its symmetry properties and consequences require independent testing:

$$\text{PredictionDependsOn}(\Phi_M) \implies \text{IndependentEmpiricalTestRequired}(\Phi_M). \quad (641)$$

If observable predictions do not depend on it, CMA alone supplies no empirical discrimination

from the relativistic application:

$$\neg \text{PredictionDependsOn}(\Phi_M) \implies \neg \text{EmpiricalDiscriminationFromCMAAlone} . \quad (642)$$

The resulting position is deliberately non-evasive. CMA is an additional ontological commitment relative to standard Lorentzian spacetime structure; it is not a theorem of special or general relativity and is not made compatible by renaming a coordinate slicing. Observational compatibility in a declared domain means only that the complete application, including any Φ_M , preserves the tested relativistic predictions within their empirical warrant. A future bridge that makes the common-stage association physically discriminating must face the corresponding Lorentz-symmetry and experimental constraints.

33.5 No automatic preferred inertial frame

The one-global-stage co-presence commitment does not itself define a preferred inertial frame:

$$\left[\forall s \in \mathcal{S}_C^{\text{tot}}, \quad \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s) \right] \not\Rightarrow \text{PreferredInertialFrame} . \quad (643)$$

Likewise:

$$T_{\text{ITOF}} \not\equiv_{\text{type}} \text{PreferredVelocityField} . \quad (644)$$

Any claim of:

$$\begin{aligned} &\text{preferred motion,} \quad \text{measurable anisotropy,} \quad \text{modified propagation,} \\ &\text{preferred dynamical frame,} \quad \text{or frame-specific physical law} \end{aligned} \quad (645)$$

would be an additional physical hypothesis.

Such a hypothesis requires:

$$\text{IndependentPhysicalModel} \wedge \text{IndependentObservableConsequences} \wedge \text{EmpiricalEvaluation} . \quad (646)$$

It cannot be inferred merely from the existence of CMA.

34. Relativistic Clock Records and Temporal Identity

34.1 Special-relativistic interval relation

A standard special-relativistic relation may be represented as:

$$\Delta\tau = \frac{\Delta t}{\gamma} . \quad (647)$$

Within V38/F18, this equation relates declared relativistic model quantities; it is not an equation for deformation or dilation of the ITOF temporal referent. Thus:

$$\Delta\tau \neq \Delta t \not\Rightarrow \text{ITOFTimeDilated} . \quad (648)$$

The conventional phrase “time dilation” may continue to identify this standard relativistic class of calculation.

ITOF rejects only the ontological inference that the entity denoted by time is literally dilated.

34.2 Separated-clock histories

Let:

$$C_A, \quad C_B \quad (649)$$

be two physical clock systems with:

$$\mathcal{H}_{C_A} = (I_{C_A}, \prec_C|_{I_{C_A}}, X_{C_A}, \Delta_{C_A}^{\text{phys}}), \quad (650)$$

$$\mathcal{H}_{C_B} = (I_{C_B}, \prec_C|_{I_{C_B}}, X_{C_B}, \Delta_{C_B}^{\text{phys}}). \quad (651)$$

Their physical histories may differ in:

$$\begin{aligned} & \text{motion,} \quad \text{gravitational environment,} \quad \text{thermal conditions,} \\ & \text{electromagnetic interactions,} \quad \text{mechanical conditions,} \quad \text{control,} \\ & \text{interrogation,} \quad \text{signal transfer,} \quad \text{and other physical variables.} \end{aligned} \quad (652)$$

A later comparison may yield:

$$d_{AB}^{\text{obs}} = \Gamma_A(N_A) - \Gamma_B(N_B) \neq 0. \quad (653)$$

The warranted direct conclusion is:

$$\text{DifferentPhysicalClockRecords}(C_A, C_B). \quad (654)$$

The record difference does not establish unequal amounts of ITOF time:

$$d_{AB}^{\text{obs}} \neq 0 \not\Rightarrow [\text{LessTimeFor}(C_A) \vee \text{MoreTimeFor}(C_B)]. \quad (655)$$

34.3 CMA and UCC in the separated-clock case

Where:

$$C_A, C_B \in \mathcal{S}_{\text{phys}}(s), \quad (656)$$

CMA gives objective common-stage co-presence:

$$\text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s), \quad (657)$$

Under UCC,

$$\text{PhysReal}_{C_A}^+(s) \wedge \text{PhysReal}_{C_B}^+(s). \quad (658)$$

UCC expresses the uninterrupted continuity of those system-specific changes throughout the respective realized identity ranges.

The clocks therefore share one common cosmic change stage while realizing different system-specific physical histories and possibly different clock outputs.

34.4 Gravitational clock comparison

A weak-field benchmark may contain:

$$\frac{\Delta\nu}{\nu} \simeq \frac{\Delta\Psi}{c^2}. \quad (659)$$

Within its warranted approximation domain, this is a relation among physical or model quantities associated with clock response under different gravitational conditions.

It does not establish:

$$\frac{\Delta\nu}{\nu} \neq 0 \not\Rightarrow \text{ITOFGravitationalTimeDilation}. \quad (660)$$

V38/F18 classifies:

$$\frac{\Delta\nu}{\nu} \quad (661)$$

as a physical or operational clock-response difference.

The model used to predict that difference may be relativistic or another independently specified physical response model.

Neither model acquires temporal identity through successful recovery.

34.5 GPS and integrated relativistic operations

Navigation systems, including GPS-class systems, may combine [11]:

$$\begin{aligned} &\text{satellite systems, physical clocks, orbital models, signal propagation,} \\ &\text{receivers, coordinate assignments, synchronization conventions,} \\ &\text{relativistic corrections, calibration, and record processing.} \end{aligned} \quad (662)$$

If:

$$\text{NavigationError} \leq \epsilon_{\text{nav}}, \quad (663)$$

then:

$$\text{GPSOperationalSuccess} \quad (664)$$

may be warranted within the declared domain.

It does not follow that:

$$\text{GPSOperationalSuccess} \not\Rightarrow t_{\text{GPS}} \equiv_{\text{type}} T_{\text{ITOF}}. \quad (665)$$

GPS success is evidence for the adequacy of the integrated physical, geometrical, signal, coordinate, clock, correction, and record architecture within its validated application domain.

It does not determine the ontological definition of time.

35. Cosmological Parameters and Temporal Identity

35.1 Cosmological coordinate parameter

A relativistic cosmological model may employ:

$$ds^2 = -c^2 dt_{\text{cos}}^2 + a^2(t_{\text{cos}}) d\Sigma_k^2. \quad (666)$$

The parameter:

$$t_{\text{cos}} \quad (667)$$

belongs to the declared cosmological model.

Even where it orders a useful family of model hypersurfaces:

$$t_{\text{cos}} \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (668)$$

35.2 Model-derived cosmological age

A cosmological model may calculate:

$$t_{\text{age}} = \int_{a_i}^{a_0} \frac{da}{aH(a; \Omega_i, \dots)}. \quad (669)$$

This is a model-derived quantitative magnitude.

It does not enumerate the members of:

$$\mathcal{S}_{\text{C}}^{\text{tot}}. \quad (670)$$

Therefore:

$$\text{CosmologicalAgeComputed}(t_{\text{age}}) \not\Rightarrow \text{CommonCosmicChangeStagesCounted}. \quad (671)$$

Nor:

$$t_{\text{age}} \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (672)$$

35.3 Cosmic origin and cosmological model origin

Where V38/F18 retains the independent Cosmic Origin commitment:

$$\text{CosmicOrigin}, \quad (673)$$

it remains logically distinct from:

$$\text{RelativisticModelOriginParameter}. \quad (674)$$

Thus:

$$\text{CosmicOrigin} \not\equiv_{\text{def}} \text{RelativisticCosmologicalBoundary}. \quad (675)$$

Agreement or disagreement between a physical cosmological model and the foundational origin postulate requires an independently developed bridge.

No identity follows from similar language such as “beginning”, “age”, or “cosmic time”.

36. ITOF–Relativity Physical Bridges

36.1 Ontological difference and empirical comparison

The foundational disagreement between ITOF and relativistic temporal identification must not be weakened by an ontological merger.

At the same time, a physical theory cannot obtain quantitative force merely by declaring a different ontology.

V38/F18 therefore distinguishes:

$$\text{OntologicalIdentification} \not\equiv_{\text{def}} \text{EmpiricalComparison} . \quad (676)$$

The bridge is an empirical-comparison architecture, not an ontological merger of temporal definitions.

36.2 No projection into spacetime geometry

The definition:

$$T_{\text{ITOF}} = \left(\mathcal{S}_{\text{C}}^{\text{tot}}, \prec_{\text{C}} \right) \quad (677)$$

does not itself derive:

$$g_{\mu\nu}, \quad ds^2, \quad \tau[\gamma, g], \quad J^{\pm}(p), \quad \Sigma_{\lambda} . \quad (678)$$

Therefore:

$$\text{TemporalDefinition}_{\text{ITOF}} \not\Rightarrow \text{RelativisticSpacetimeGeometry} . \quad (679)$$

Likewise, neither foundational commitment supplies the corresponding relativistic mathematical structure:

$$\text{CMA} \not\Rightarrow \text{RelativisticMetricStructureSpecified}, \quad (680)$$

$$\text{UCC} \not\Rightarrow \text{ProperTimeFunctionalSpecified} . \quad (681)$$

No mathematical projection from the temporal definition to relativistic geometry is part of the definition of time.

36.3 No requirement of ontological recovery

Validity of ITOF does not entail recovery of a relativistic temporal ontology:

$$\text{ValidITOF} \not\Rightarrow \text{RelativisticTemporalOntologyRecovered} . \quad (682)$$

Such a requirement would erase the foundational disagreement before testing it.

What may be required in a physical domain is empirical recovery or discrimination of observed physical records.

Thus:

$$\text{PhysicalCompetitionOn}(D) \implies \text{ObservableRecoveryOrDiscriminationOn}(D), \quad (683)$$

not:

$$\text{TemporalOntologyIdentity}. \quad (684)$$

Observable model discrimination therefore does not by itself establish an identity claim about the temporal ontology.

36.4 Two independent application branches

Let:

$$F_I \quad (685)$$

denote the relevant ITOF foundational commitments.

Let:

$$M_I \quad (686)$$

be an independently specified physical application model consistent with those commitments.

Let:

$$M_R \quad (687)$$

be the declared relativistic comparison model.

The ITOF branch is:

$$F_I \wedge M_I \wedge B_I^{\text{phys}} \wedge \mathcal{P}_I \vdash \hat{\mathbf{y}}^I. \quad (688)$$

The relativistic branch is:

$$M_R \wedge B_R^{\text{phys}} \wedge \mathcal{P}_R \vdash \hat{\mathbf{y}}^R. \quad (689)$$

Both predictions must then be related to one declared empirical comparison space through their own warranted observation and acquisition bridges.

36.5 Common observable space

For the vector-valued comparison developed below, let

$$\mathcal{Y}_{\text{obs}}^{P,D} \subseteq \mathbb{R}^{m_{P,D}}, \quad m_{P,D} \in \mathbb{N}_{>0}, \quad (690)$$

be the common empirical output space in which the rival predictions are actually compared. Vector subtraction is therefore defined in the ambient space $\mathbb{R}^{m_{P,D}}$. Where a protocol has non-vector-valued outputs, it must supply a separately declared comparison functional; the vector and inverse-covariance formulas below then apply only after a warranted embedding into such a numerical comparison space.

Define:

$$\Pi_I^{P,D} : \hat{\mathcal{Y}}_I \longrightarrow \mathcal{Y}_{\text{obs}}^{P,D}, \quad (691)$$

$$\Pi_R^{P,D} : \hat{\mathcal{Y}}_R \longrightarrow \mathcal{Y}_{\text{obs}}^{P,D}. \quad (692)$$

Then:

$$\mathbf{y}_I^{P,D} = \Pi_I^{P,D}(\hat{\mathbf{y}}^I), \quad (693)$$

$$\mathbf{y}_R^{P,D} = \Pi_R^{P,D}(\hat{\mathbf{y}}^R). \quad (694)$$

The common empirical codomain permits comparison.

It does not create ontological identity between the theories.

36.6 Observable comparison bridge

Define the comparison architecture:

$$\mathfrak{B}_{I:R}^{P,D} := (B_I^{\text{phys}}, B_R^{\text{phys}}, \Pi_I^{P,D}, \Pi_R^{P,D}, \mathcal{P}_I, \mathcal{P}_R, \Sigma_{I:R}). \quad (695)$$

This is the V38/F18 ITOF–relativistic observable comparison bridge.

Its status is:

$$\text{Status}(\mathfrak{B}_{I:R}^{P,D}) = \text{ApplicationLevelEmpiricalComparisonArchitecture}. \quad (696)$$

The bridge compares physical predictions. It is not a temporal-identity merger, an ontological merger, a definition of time, or an identity map between ITOF time and a relativistic temporal quantity.

36.7 No bridge by coordinate naming alone

Coordinate assignment alone does not supply a physical association with a common cosmic change stage:

$$\text{CoordinateAssigned}_F(e) \not\Rightarrow \text{PhysicalAssociationWithCommonCosmicChangeStage}(e). \quad (697)$$

Likewise:

$$t_F(e) = t_0 \quad (698)$$

does not establish:

$$t_F(e) = t_0 \not\Rightarrow \text{ExactCosmicChangeStageIdentified}(e). \quad (699)$$

Any claimed physical association between observable data and common cosmic change-stage realization requires a separately declared association bridge.

36.8 Physical association burden

For protocol P and model M :

$$\text{CommonCosmicChangeStageDataClaim}_{P,M} \implies \text{DeclaredPhysicalAssociationBridge}_{P,M}. \quad (700)$$

Let:

$$\mathcal{Q}_{P,M}^{\text{assoc}} \quad (701)$$

be the set of physically applicable association components selected from:

$$\begin{aligned} &\text{source attribution,} \quad \text{propagation/path model,} \quad \text{detector interaction,} \\ &\quad \text{record formation,} \quad \text{reconstruction,} \quad \text{calibration,} \\ &\text{system identification,} \quad \text{uncertainty characterization.} \end{aligned} \quad (702)$$

Then:

$$\begin{aligned} \text{DeclaredPhysicalAssociationBridge}_{P,M} \implies \text{ApplicabilitySetFixedIndependently}_{P,M} \left(\mathcal{Q}_{P,M}^{\text{assoc}} \right) \\ \wedge \forall q \in \mathcal{Q}_{P,M}^{\text{assoc}}, \quad \text{DeclaredAndWarranted}_{P,M}(q). \end{aligned} \quad (703)$$

A component may be omitted where it is physically inapplicable.

Its omission must not be chosen post hoc to absorb a failed prediction or unresolved attribution.

36.9 Recovery bridge

Suppose the ITOF application model is constructed to recover an established relativistic prediction on benchmark domain D_{rec} .

Let the two application branches be projected through their independently specified observation maps into the common benchmark observable space:

$$\mathbf{y}_{I,\text{rec}}^{P,D_{\text{rec}}} = \Pi_I^{P,D_{\text{rec}}} \left(\hat{\mathbf{y}}_{\text{rec}}^I \right), \quad (704)$$

$$\mathbf{y}_{R,\text{rec}}^{P,D_{\text{rec}}} = \Pi_R^{P,D_{\text{rec}}} \left(\hat{\mathbf{y}}_{\text{rec}}^R \right). \quad (705)$$

A recovery condition may then be stated in that common empirical codomain:

$$\left\| \mathbf{y}_{I,\text{rec}}^{P,D_{\text{rec}}} - \mathbf{y}_{R,\text{rec}}^{P,D_{\text{rec}}} \right\|_{\Sigma_{I:R}^{-1}} \leq \varepsilon_{\text{rec}}. \quad (706)$$

The comparison norm, covariance, and threshold must be declared in advance.

Successful recovery warrants:

$$\text{ITOFApplicationRecoversBenchmarkOn}(D_{\text{rec}}). \quad (707)$$

It does not establish:

$$\begin{aligned} &\text{ITOFApplicationRecoversBenchmarkOn}(D_{\text{rec}}) \\ &\not\Rightarrow \text{ITOFTemporalOntology} = \text{RelativisticTemporalOntology}. \end{aligned} \quad (708)$$

36.10 Recovery is not discrimination

If the common-observable predictions satisfy:

$$\mathbf{y}_I^{P,D} \approx \mathbf{y}_R^{P,D} \quad (709)$$

within the declared combined uncertainty, the two application models may be empirically indistinguishable on that domain.

Thus:

$$\text{BenchmarkRecovered} \not\Rightarrow \text{ITOFFoundationallyConfirmed}. \quad (710)$$

And:

$$\text{BenchmarkRecovered} \not\Rightarrow \text{RelativisticTemporalIdentityAccepted}. \quad (711)$$

Recovery establishes quantitative adequacy of the tested application chain on the declared benchmark domain.

Nothing more follows automatically.

36.11 Discriminating prediction

For a genuine quantitative confrontation, define:

$$\Delta_{I:R}^{P,D} := \mathbf{y}_I^{P,D} - \mathbf{y}_R^{P,D}. \quad (712)$$

A necessary discrimination condition is:

$$\text{ResolvedPredictionSeparation}_{I:R} \implies \left\| \Delta_{I:R}^{P,D} \right\|_{\Sigma_{I:R}^{-1}} > \eta_\star, \quad (713)$$

where:

$$\eta_\star > 0 \quad (714)$$

is a predeclared protocol threshold appropriate to the comparison.

The foundation does not assign one universal numerical value to $\eta_\star$.

36.12 Prediction separation must precede outcome inspection

Define the predeclared comparison specification:

$$\mathcal{Q}_{I:R}^{P,D} := \left(\mathbf{y}_I^{P,D}, \mathbf{y}_R^{P,D}, \Sigma_{I:R}, \eta_\star \right). \quad (715)$$

A prediction difference has genuine advance-discrimination status only if:

$$\text{AdvanceRelativityDiscrimination} \implies \text{OutcomeIndependentSpecification} \left(\mathcal{Q}_{I:R}^{P,D} \right). \quad (716)$$

A difference manufactured after viewing the data is not an independent prediction.

36.13 Bridge symmetry at the comparison level

Empirical comparison should not permit one model to receive unexamined bridge freedom denied to the other.

Thus:

$$\text{FairModelComparison}_{I:R} \implies \text{BridgeRequirementsAppliedByDeclaredRole}. \quad (717)$$

This does not require identical physical premises for two different models.

It requires that:

$$\begin{aligned}
& \text{each necessary bridge be declared,} \\
& \text{each parameter have provenance,} \\
& \text{each uncertainty contribution be represented,} \\
& \text{and no model receive outcome-dependent auxiliary freedom.}
\end{aligned} \tag{718}$$

36.14 Bridge-robust prediction separation

A single pair of bridge choices can display prediction separation while other independently admissible bridge choices remove it. Foundation-sensitive comparison therefore requires the residual bridge freedom to be represented explicitly rather than absorbed into one preferred application map.

Let

$$\mathbb{B}_I^{P,D} \neq \emptyset, \quad \mathbb{B}_R^{P,D} \neq \emptyset \tag{719}$$

be the independently specified admissible bridge classes for the ITOF and relativistic application branches. Membership in those classes must be fixed by outcome-independent admissibility conditions:

$$\text{AdmissibleBridgeClasses}_{I:R}(P, D) \implies \text{OutcomeIndependentMembershipRule}(\mathbb{B}_I^{P,D}, \mathbb{B}_R^{P,D}). \tag{720}$$

Residual bridge freedom is present when at least one branch admits more than one independently acceptable bridge realization:

$$\text{ResidualBridgeFreedom}_{I:R}(P, D) \iff |\mathbb{B}_I^{P,D}| > 1 \vee |\mathbb{B}_R^{P,D}| > 1. \tag{721}$$

For $b_I \in \mathbb{B}_I^{P,D}$ and $b_R \in \mathbb{B}_R^{P,D}$, let

$$d_{I:R}^{P,D}(b_I, b_R) := \left\| \mathbf{y}_I^{P,D}(b_I) - \mathbf{y}_R^{P,D}(b_R) \right\|_{\Sigma^{-1}(b_I, b_R)}. \tag{722}$$

The covariance entering the norm must include the declared shared and branch-specific uncertainty contributions applicable to that bridge pair. Where the inverse-covariance norm in Eq. (722) is used, the applicable covariance must be positive definite on the evaluated observable subspace:

$$\forall b_I \in \mathbb{B}_I^{P,D} \forall b_R \in \mathbb{B}_R^{P,D}, \quad \Sigma(b_I, b_R) \succ 0. \tag{723}$$

If a domain requires a singular covariance treatment, the protocol must replace the inverse norm by a predeclared mathematically valid alternative rather than silently applying an undefined inverse.

Define the bridge-robust separation margin:

$$\delta_{I:R}^{P,D} := \inf_{\substack{b_I \in \mathbb{B}_I^{P,D} \\ b_R \in \mathbb{B}_R^{P,D}}} d_{I:R}^{P,D}(b_I, b_R). \tag{724}$$

For a predeclared threshold $\eta_\star > 0$, define:

$$\text{RobustBridgeSeparation}_{I:R}(P, D; \eta_\star) \iff \delta_{I:R}^{P,D} > \eta_\star. \quad (725)$$

This condition states that every independently admissible bridge pair preserves a resolved prediction separation. It is stronger than separation obtained from one selected bridge pair and remains a necessary, not sufficient, condition for a foundation-sensitive inference whenever unresolved bridge freedom is present.

Accordingly:

$$\begin{aligned} & \text{ResidualBridgeFreedom}_{I:R}(P, D) \wedge \text{Warrant}_{P,D} [\text{FoundationalDiscrimination}(F_I, F_R)] \\ & \implies \text{RobustBridgeSeparation}_{I:R}(P, D; \eta_\star). \end{aligned} \quad (726)$$

If

$$\delta_{I:R}^{P,D} \leq \eta_\star, \quad (727)$$

then admissible bridge freedom can eliminate the predeclared separation. The comparison may still discriminate particular application realizations, but that separation alone does not isolate the foundational difference.

36.15 Attribution of a discriminating result

Suppose observation favours:

$$M_I \quad (728)$$

over:

$$M_R. \quad (729)$$

The immediate warranted claim is:

$$\text{DiscriminationFavours}(M_I) \implies \text{Warrant} [\text{ITOFApplicationModelSupportedOn}(D)]. \quad (730)$$

It does not automatically establish:

$$\text{DiscriminationFavours}(M_I) \not\Rightarrow \text{CMAEmpiricallyEstablished}. \quad (731)$$

Nor:

$$\text{DiscriminationFavours}(M_I) \not\Rightarrow \text{UCCEmpiricallyEstablished}. \quad (732)$$

A foundational conclusion requires identifiable dependence of the prediction difference on the relevant foundational difference.

36.16 Relativistic Success and ITOF Type Claims

Conversely, suppose:

$$\text{DiscriminationFavours}(M_R). \quad (733)$$

The direct conclusion concerns the compared application models:

$$\text{DiscriminationFavours}(M_R) \implies \text{ITOFApplicationModelRejectedOrRestrictedOn}(D) \quad (734)$$

where the comparison satisfies the declared protocol.

The result does not license replacement of the V38/F18 type assignments. They remain:

$$t_F \not\equiv_{\text{type}} T_{\text{ITOF}}, \quad \tau[\gamma, g] \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (735)$$

Empirical success of a physical representation and the definition of time remain logically different questions.

36.17 Condition for genuinely foundational discrimination

Let:

$$F_I \quad (736)$$

contain an ITOF foundational commitment and:

$$F_R \quad (737)$$

the explicitly declared rival foundational proposition.

A genuine foundational comparison requires:

$$F_I \wedge B_I \wedge \mathcal{P}_I \vdash O_I, \quad (738)$$

$$F_R \wedge B_R \wedge \mathcal{P}_R \vdash O_R. \quad (739)$$

Then:

$$\begin{aligned} & \text{Warrant}_{P,D} [\text{FoundationalDiscrimination}(F_I, F_R)] \\ \implies & \text{OutcomeIndependentSpecification}(B_I, B_R, \mathcal{P}_I, \mathcal{P}_R) \\ & \wedge \text{ProtocolFrozen}(P) \\ & \wedge \text{NoEvaluationLeakage}(P, D) \\ & \wedge \text{PredictionSeparationBeyondCombinedUncertainty}(O_I, O_R; P, D) \\ & \wedge \text{FoundationalAttributionIdentifiable}(F_I, F_R; B_I, B_R, \mathcal{P}_I, \mathcal{P}_R; P, D). \end{aligned} \quad (740)$$

Where residual bridge freedom remains, Eq. (726) adds the bridge-robust separation requirement to this burden. If the observable separation can be removed by an independently admissible bridge variation while the foundational commitments are held fixed, the result does not isolate the foundational difference.

36.18 The bridge cannot establish ontological identity

Suppose:

$$\mathbf{y}_I^{P,D} \approx \mathbf{y}_R^{P,D} \approx \mathbf{y}_{\text{obs}}. \quad (741)$$

Then:

$$\text{BothModelsEmpiricallyAdequateOn}(D) \quad (742)$$

may be warranted.

It does not follow that:

$$\text{BothModelsEmpiricallyAdequateOn}(D) \not\Rightarrow T_{\text{ITOF}} \equiv_{\text{type}} \tau[\gamma, g]. \quad (743)$$

or:

$$\text{BothModelsEmpiricallyAdequateOn}(D) \not\Rightarrow \text{CosmicCoPresence}_{\text{C}} \equiv_{\text{type}} \sim_F. \quad (744)$$

Empirical equivalence on a finite domain is not ontological identity.

36.19 Application Tests Do Not Automatically Refute the Core

Likewise, if:

$$\mathbf{y}_I^{P,D} \not\approx \mathbf{y}_{\text{obs}}, \quad (745)$$

the tested application chain may be inadequate on that domain.

It does not automatically follow that:

$$\text{TemporalDefinitionRejected}_{\text{ITOF}} \quad \neg \text{CMA}, \quad \text{or} \quad \neg \text{UCC}. \quad (746)$$

The foundational consequence must be derived, not presumed.

36.20 Bridge claim boundary

The admissible V38/F18 bridge claim is:

ITOF and a relativistic physical model may be brought into direct quantitative comparison only after each has been connected independently to the same observable domain through explicit physical, acquisition, calibration, and uncertainty structures. Agreement establishes bounded empirical adequacy of the respective application model; disagreement establishes model-level discrimination where resolved. A foundational conclusion requires the observed separation to be independently traceable to the foundational difference itself; where residual bridge freedom exists, that separation must remain resolved across the independently admissible bridge classes. The comparison bridge does not identify coordinate time, metric interval, proper time, simultaneity convention, spacetime geometry, or clock output with the entity denoted by time in ITOF.

This is a bridge of empirical confrontation.

It is not a bridge that identifies the temporal referents.

37. Relativistic Type Register

37.1 Temporal identity conflict

ITOF:

$$T_{\text{ITOF}} = (\mathcal{S}_{\text{C}}^{\text{tot}}, \prec_{\text{C}}). \quad (747)$$

Relativistic temporal quantity under examination:

$$q_R \in \mathcal{Q}_{\text{rel}}. \quad (748)$$

ITOF therefore assigns the direct type relation:

$$q_R \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (749)$$

37.2 Common-stage conflict

An ontology of mutually private ITOF cosmic-stage domains conflicts with the framework's single-domain architecture. Within V38/F18, failure of CMA is specifically

$$\neg \text{CMA} \iff \exists s \in \mathcal{S}_C^{\text{tot}} : \neg \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s). \quad (750)$$

This countercondition concerns objective co-presence and is distinct from UCC failure, which requires a realized qualified system with complete physical non-change at an admitted member.

37.3 Private-time conflict

ITOF already fixes that many physical histories do not imply many times in Eq. (224). Any interpretation asserting that distinct physical-system path functionals are literally distinct temporal extensions conflicts with this type architecture.

Thus:

$$\text{PathDependentMetricQuantity}(A) \not\Rightarrow \text{PrivateTemporalExtension}(A). \quad (751)$$

37.4 Metric-time conflict

ITOF does not define a temporal metric:

$$T_{\text{ITOF}} \not\equiv_{\text{type}} \text{MetricSpaceTimeQuantity}. \quad (752)$$

Therefore an ontology identifying time itself with metric interval conflicts with the governing ITOF definition.

37.5 Causal-time conflict

ITOF fixes the causal type boundary:

$$\neg \text{TimeCausesPhysicalChange}. \quad (753)$$

Physical differences attributed in another model to variation of a quantity named “time” are therefore classified in ITOF through the physical systems, fields, conditions, interactions, paths, and record-production processes involved.

This does not predetermine the quantitative response.

It fixes the permissible causal type.

37.6 Empirical status of the conflict register

The conflict register identifies logical and ontological disagreement.

The conflict register alone entails neither empirical refutation of relativity nor empirical confir-

mation of ITOF:

$$\begin{aligned} \text{RelativisticConflictRegister} \not\Rightarrow \text{EmpiricalRefutationOfRelativity} \\ \vee \text{EmpiricalConfirmationOfITOF} . \end{aligned} \quad (754)$$

Those stronger conclusions require the observable comparison architecture of Section 36.

38. ITOF–Relativity Boundary

38.1 Foundational conclusion

The V38/F18 type-level conclusion is:

$$\forall q \in \mathcal{Q}_{\text{rel}}, \quad q \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (755)$$

The governing temporal definition remains Eq. (10). Its governing stage semantics already requires every admitted member to be a formal stage expression of realized physical change and therefore entails a nonempty qualified change-realizing population; CSPP records that derived population consequence.

The single universal formal domain of cosmic stages excludes private ITOF private stage-domain sequences. CMA requires objective co-presence of the complete then-realized qualified population at one common cosmic stage. UCC independently requires actual physical change in every qualified system represented at each admitted member: physical change does not cease anywhere throughout each realized identity range. Under the governing definitions CMA and UCC are logically distinct.

CRP supplies nonempty physically admissible causal realization for those actual changes.

None of these commitments is replaced by a coordinate, metric, proper-time, foliation, synchronization, or clock construction.

38.2 Type-level and empirical separation

V38/F18 therefore separates three levels that must not be conflated:

$$\begin{aligned} \text{FoundationalTemporalIdentity} &\not\equiv_{\text{def}} \text{RelativisticRepresentation}, \\ \text{RelativisticRepresentation} &\not\equiv_{\text{def}} \text{PhysicalRecord}, \\ \text{PhysicalRecordAgreement} &\not\equiv_{\text{def}} \text{TemporalIdentity} . \end{aligned} \quad (756)$$

The foundational disagreement remains direct.

The empirical comparison remains open to physical investigation.

No identity or merger between the competing temporal identifications is asserted.

38.3 What V38/F18 does claim

V38/F18 claims:

$$\begin{aligned} & \text{one universal cosmic extension,} \\ & \text{one invariant universal earlier-later ordering,} \\ & \text{one common cosmic change-stage realization,} \\ & \text{system-specific physical change,} \\ & \text{system-specific physical causation,} \\ & \text{and type-distinct physical and operational measurements.} \end{aligned} \tag{757}$$

It further claims that successful quantitative comparison with external physical theories must proceed through independently specified physical and observational bridges.

38.4 What V38/F18 does not claim

The foundational temporal definition alone does not derive Lorentz transformations, Einstein field equations, clock shifts, gravitational redshift, signal-propagation laws, orbital dynamics, or other domain-specific quantitative predictions:

$$\text{TemporalDefinition}_{\text{ITOF}} \not\Rightarrow \text{RelativisticDomainSpecificDynamicsOrPredictions} . \tag{758}$$

Such predictions require physical application models.

Nor does V38/F18 claim that conceptual disagreement with relativistic temporal ontology constitutes experimental falsification of relativity.

38.5 Required future quantitative route

The scientifically admissible route is:

$$\begin{aligned} \text{ITOFFoundationalCommitment} & \longrightarrow \text{IndependentPhysicalApplicationModel} \\ & \longrightarrow \text{FrozenQuantitativePrediction} \\ & \longrightarrow \text{MeasurementAndRecordBridge} \\ & \longrightarrow \text{ObservableComparison} \\ & \longrightarrow \text{ModelDiscrimination} \\ & \longrightarrow \text{FoundationalAttributionWhereIdentifiable} . \end{aligned} \tag{759}$$

The route permits no ontological conclusion beyond the dependency actually established by the physical and observational derivation.

39. Signals and Remote Physical Access

Signals and remote records are treated as physical source–propagation–receiver chains within the common cosmic ordering. The earlier relativistic causal-domain section used only the subset

of these distinctions required to separate common-stage realization from model-specific causal accessibility.

39.1 Signals are physical processes

A signal relation contains physically realized systems, fields, interactions, or other physically admissible carriers and factors.

For a declared source–receiver chain Γ , the physical sequence may be represented schematically as:

$$\begin{aligned} \text{SourceChange} \rightsquigarrow_{\text{phys}} \text{Emission} \rightsquigarrow_{\text{phys}} \text{Propagation} \\ \rightsquigarrow_{\text{phys}} \text{ReceiverInteraction} \rightsquigarrow_{\text{phys}} \text{RecordFormation} . \end{aligned} \quad (760)$$

Every physical-system identity participating in the chain remains governed by the same common cosmic ordering.

Where a participating entity A is independently qualified as a physical system and:

$$A \in \mathcal{S}_{\text{phys}}(s), \quad (761)$$

UCC gives:

$$\text{PhysReal}_A^+(s). \quad (762)$$

The physical signal chain therefore belongs to the system-specific physical realization architecture. It is not a temporal transport chain.

39.2 Record-lag decomposition

A declared operational record lag may be represented as:

$$\begin{aligned} L_{\Gamma}^{\text{rec}} = L_{\Gamma}^{\text{emit}} + L_{\Gamma}^{\text{prop}} + L_{\Gamma}^{\text{path}} \\ + L_{\Gamma}^{\text{interaction}} + L_{\Gamma}^{\text{detect}} + L_{\Gamma}^{\text{process}} . \end{aligned} \quad (763)$$

Every term in this expression is an operationally or physically defined quantity under the declared signal model.

A positive lag:

$$L_{\Gamma}^{\text{rec}} > 0 \quad (764)$$

does not imply:

$$L_{\Gamma}^{\text{rec}} > 0 \not\Rightarrow \text{MultipleTemporalReferentsExist} . \quad (765)$$

Nor:

$$L_{\Gamma}^{\text{rec}} > 0 \not\Rightarrow \text{CosmicChangeStageDelayed} . \quad (766)$$

The delay belongs to the physical and operational chain.

39.3 Signals do not transport time

For a physical signal:

$$S : A \rightarrow B, \quad (767)$$

V38/F18 retains:

$$\text{SignalPropagation}(S) \not\Rightarrow \text{TimeTransported}(A \rightarrow B). \quad (768)$$

Likewise:

$$\text{SignalArrivalAt}(B; s) \not\Rightarrow \text{TimeArrivesAt}(B; s). \quad (769)$$

A signal may transport:

$$\begin{aligned} &\text{energy, momentum, information-bearing physical variation,} \\ &\text{or another physically warranted quantity,} \end{aligned} \quad (770)$$

depending on the applicable physical theory.

It does not transport the universal cosmic extension.

39.4 Remote source and receiver

Let:

$$A_S \quad (771)$$

be a remote source system and:

$$A_D \quad (772)$$

a detector or receiving system.

A record r_D received by A_D may be physically attributable to an earlier source manifestation:

$$\text{ManifestationAt}(A_S, \chi_S; s_S). \quad (773)$$

The record remains:

$$r_D \not\equiv_{\text{type}} \chi_S, \quad (774)$$

and:

$$r_D \not\equiv_{\text{type}} s_S. \quad (775)$$

A valid physical source–record bridge may warrant:

$$\text{Warrant}_{P,M} [\exists s_S \in I_{A_S} \text{ ManifestationAt}(A_S, \chi_S; s_S)]. \quad (776)$$

It does not thereby identify that exact member of $\mathcal{S}_C^{\text{tot}}$.

39.5 Remote access delay does not delay remote physical change

Suppose the detector receives at common cosmic change stage s_D a record associated with source manifestation at some:

$$s_S \prec_C s_D. \quad (777)$$

The record-arrival stage is not the source stage.

Nor does delayed access imply delayed physical participation by the remote system:

$$\text{RemoteAccessDelayed}(A_S, A_D) \not\Rightarrow \text{RemotePhysicalChangeDelayed}(A_S). \quad (778)$$

If both identities are realized at a later current common cosmic change stage a :

$$A_S, A_D \in \mathcal{S}_{\text{phys}}(a), \quad (779)$$

then CMA supplies their objective common-stage co-presence at a , while UCC requires their respective actual physical changes:

$$\text{UCC} \wedge A_S, A_D \in \mathcal{S}_{\text{phys}}(a) \implies \text{PhysReal}_{A_S}^+(a) \wedge \text{PhysReal}_{A_D}^+(a). \quad (780)$$

UCC states the corresponding uninterrupted system-specific continuity throughout each realized identity range.

The arrival of an older record at A_D does not place the presently realized source identity in a private past time.

39.6 Successive remote records

Let two source manifestations:

$$\chi_1, \quad \chi_2 \quad (781)$$

belong to the same source identity A_S .

Suppose a warranted physical reconstruction establishes:

$$\exists s_1, s_2 \in I_{A_S}, \quad s_1 \prec_C s_2, \quad (782)$$

with:

$$\text{ManifestationAt}(A_S, \chi_1; s_1) \wedge \text{ManifestationAt}(A_S, \chi_2; s_2). \quad (783)$$

Let the reconstructed record separation satisfy:

$$\Delta_{\text{arr}} = \Delta_{\text{src}} + \Delta_{\text{prop}}. \quad (784)$$

Here:

$$\Delta_{\text{src}} \quad (785)$$

is an operational representation of source-development separation under the declared reconstruction model, while:

$$\Delta_{\text{prop}} \quad (786)$$

contains differential path, propagation, lensing, medium, source-motion, detector, and reconstruction contributions where physically applicable.

If:

$$|\Delta_{\text{prop}}| \leq \varepsilon_{\text{prop}}, \quad (787)$$

then:

$$|\Delta_{\text{arr}} - \Delta_{\text{src}}| \leq \varepsilon_{\text{prop}}. \quad (788)$$

This may warrant relative source development without identifying the exact stage pair:

$$\begin{aligned} & \text{Warrant}_{P,M} [\exists s_1, s_2 \in I_{A_S} (s_1 \prec_C s_2)] \\ & \Rightarrow \text{ExactCosmicChangeStagePairIdentified}_{P,M}(A_S, \chi_1, \chi_2). \end{aligned} \quad (789)$$

39.7 Large propagation delay and common-stage unity

A very large propagation delay does not enlarge or divide the common cosmic change stage:

$$L_T^{\text{prop}} \gg 0 \not\Rightarrow \text{CommonCosmicChangeStageSplit}. \quad (790)$$

Nor does:

$$L_T^{\text{prop}} \gg 0 \not\Rightarrow \text{RemoteSystemHasDifferentTime}. \quad (791)$$

Propagation delay concerns access to information-bearing physical records.

The one-global-stage architecture supplies the common formal cosmic-stage domain; CMA concerns objective common-stage co-presence.

39.8 Light and radiation

A radiation pulse, photon-qualified entity, excitation, beam, field object, or other radiation-model object belongs to $\mathcal{U}_{\text{phys}}$ only if it independently satisfies the applicable physical-system identity criterion.

Thus:

$$\text{RadiationModelObject}(R) \not\Rightarrow \text{PhysicalSystem}(R). \quad (792)$$

Where $R \in \mathcal{U}_{\text{phys}}$ and $R \in \mathcal{S}_{\text{phys}}(s)$, UCC gives:

$$\text{UCC} \wedge R \in \mathcal{S}_{\text{phys}}(s) \implies \text{PhysReal}_R^+(s). \quad (793)$$

Propagation, scattering, attenuation, interference, refraction, lensing, spectral change, path deviation, polarization change, and detector interaction remain physical phenomena.

Therefore:

$$\text{OpticalPathDeviation}(R) \not\Rightarrow \text{TimeBent}, \quad (794)$$

and:

$$\text{RadiationArrivalDelay}(R) \not\Rightarrow \text{TimeDelayed}. \quad (795)$$

39.9 Remote Records in Physical Realization

For a source stage s_S , the source system belongs to:

$$\mathfrak{R}_C(s_S). \quad (796)$$

At the later detector-record stage s_D , the detector and record-producing systems belong to:

$$\mathfrak{R}_C(s_D). \quad (797)$$

The physical source–record chain therefore connects physical realizations across the invariant order.

It does not identify the two stage-relative profiles:

$$s_S \prec_C s_D \not\Rightarrow \mathfrak{R}_C(s_S) = \mathfrak{R}_C(s_D). \quad (798)$$

Nor does it require a universal deterministic map from the earlier complete profile to the later complete profile.

The physical propagation model supplies only the dependencies warranted for the particular source–signal–receiver system.

40. Quantum Records and System Identity

40.1 Mathematical-form-neutral treatment

V38/F18 does not adopt one interpretation of quantum mechanics as part of the definition of time.

Quantum mathematical structures enter through the mathematical-form-neutral physical-model architecture defined in Section 18.

The formal time definition remains

$$T_{\text{TOF}} = (\mathcal{S}_C^{\text{tot}}, \prec_C). \quad (799)$$

40.2 Quantum model objects are not automatically physical systems

A state vector:

$$|\psi\rangle, \quad (800)$$

density operator:

$$\rho, \quad (801)$$

operator:

$$\hat{O}, \quad (802)$$

path amplitude, probability distribution, entanglement relation, or superposition notation is not automatically a numerical physical-system identity.

Thus:

$$\text{ModelState}(|\psi\rangle) \not\Rightarrow \text{PhysicalSystem}(|\psi\rangle), \quad (803)$$

and:

$$\text{DensityOperator}(\rho) \not\Rightarrow \text{PhysicalSystem}(\rho). \quad (804)$$

Likewise:

$$\text{QuantumOperator}(\hat{O}) \not\Rightarrow \text{PhysicalSystem}(\hat{O}). \quad (805)$$

Their model status must be distinguished from the physical-system identities they may represent.

40.3 Quantum model objects are not time

The generalized Non-Transfer Principle gives:

$$|\psi\rangle \not\equiv_{\text{type}} T_{\text{ITOF}}, \quad \rho \not\equiv_{\text{type}} T_{\text{ITOF}}, \quad \hat{O} \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (806)$$

A parameter appearing in a quantum evolution equation remains governed by the model-parameter Non-Transfer rule.

For example, where:

$$i\hbar \frac{\partial}{\partial \lambda} |\psi(\lambda)\rangle = \hat{H} |\psi(\lambda)\rangle, \quad (807)$$

the formal role of λ is fixed by the declared quantum model.

Its occurrence as an evolution parameter does not alter the governing type assignment:

$$\lambda \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (808)$$

40.4 Joint quantum states and system number

For joint state q_{AB} :

$$\text{JointQuantumState}(q_{AB}) \not\Rightarrow \text{PhysicalSystemNumber}(q_{AB}). \quad (809)$$

A physically warranted classification may involve:

$$\begin{aligned} &\text{two or more independently qualified systems,} \\ &\text{one composite system,} \\ &\text{a composite together with independently qualified subsystems,} \\ &\text{or another physically justified identity architecture.} \end{aligned} \quad (810)$$

The hierarchical composition relation:

$$A \triangleleft_{\kappa, s} B \quad (811)$$

may be used only where the physical identity and composition criteria justify it.

Quantum-state notation alone does not decide that relation.

40.5 Entanglement and Temporal Type

An entanglement relation does not by itself establish a private time or a second cosmic ordering:

$$\text{Entangled}_M(A, B) \not\Rightarrow \text{PrivateTime}(A, B), \quad (812)$$

$$\text{Entangled}_M(A, B) \not\Rightarrow \text{SecondCosmicOrdering}. \quad (813)$$

Where:

$$A, B \in \mathcal{S}_{\text{phys}}(s), \quad (814)$$

The global-stage architecture supplies the common formal cosmic-stage domain independently of the entanglement classification. CMA requires objective co-presence of the represented qualified population at the shared member, while UCC requires the respective system-specific physical

changes and their continuation without admitted stasis throughout each realized identity range.

40.6 Quantum measurement

Let a quantum measurement arrangement contain physical source or sample, apparatus, interaction, detector, environment, record-bearing, observer, and laboratory or reference systems. Where those entities satisfy the governing physical-system criteria, each has its own identity-bounded history in the one cosmic succession and is subject to UCC at every stage at which it remains realized. Their stage-relative realizations belong to:

$$\mathfrak{R}_C(s). \quad (815)$$

No measurement-system component is assigned a changeless standpoint outside the physical process merely because it functions as an observer, detector, reference, or laboratory standard.

A detector outcome:

$$r_Q \quad (816)$$

is a physical record.

Thus:

$$r_Q \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (817)$$

A probability:

$$P(o|\psi, M) \quad (818)$$

is a model quantity:

$$P(o|\psi, M) \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (819)$$

40.7 Physical transformation versus representational update

If terminology such as “collapse” denotes an actual physical transformation of a qualified physical system, then:

$$\text{PhysicalCollapse}_M(A; s) \implies \text{PhysReal}_A^+(s) \quad (820)$$

where the applicable physical interpretation and system attribution are independently warranted.

If the same terminology instead denotes a change in state assignment, conditional description, information, or statistical representation, then the change belongs to the representational level.

Therefore:

$$\text{CollapseNotationChanged} \not\Rightarrow \text{PhysicalSystemIdentityChanged}. \quad (821)$$

And:

$$\text{CollapseNotationChanged} \not\Rightarrow \text{CosmicOrderingChanged}. \quad (822)$$

40.8 Delayed-choice and quantum-eraser records

Delayed-choice and quantum-eraser experiments provide concrete record-level contexts in which later measurement settings or later correlation classifications must be distinguished from retroactive physical alteration [27, 28, 29]. A delayed measurement setting or later correlation classification does not retroactively reverse the universal cosmic ordering.

Thus:

$$\text{LaterCorrelationClassification}(r) \not\Rightarrow \text{EarlierPhysicalRealizationAltered} . \quad (823)$$

Likewise:

$$\text{DelayedChoiceRecord}(r) \not\Rightarrow \exists \prec'_C \neq \prec_C . \quad (824)$$

A later record may alter the scientifically warranted description assigned to an earlier process.

It does not make a later common cosmic change stage earlier.

40.9 Quantum correlations and causal attribution

Observed quantum correlations are physical-record relations whose theoretical interpretation depends on the declared quantum model.

Their existence does not automatically identify:

$$\text{QuantumCorrelation}(A, B) \not\Rightarrow \text{SpecificPhysicalCausalMechanism}(A, B) . \quad (825)$$

Nor does:

$$\text{QuantumCorrelation}(A, B) \not\Rightarrow \text{InstantaneousCausalSignal}(A, B) . \quad (826)$$

CMA does not supply such a mechanism either.

The physical causal interpretation must remain independently warranted.

41. Higher-Dimensional Representations

41.1 Mathematical dimension and physical realization

Let:

$$\mathcal{M}_n \quad (827)$$

be an n -dimensional mathematical manifold, embedding space, state space, configuration space, phase space, or coordinate representation.

Its mathematical consistency may satisfy:

$$\text{MathematicallyConsistent}(\mathcal{M}_n) . \quad (828)$$

It does not follow that:

$$\text{MathematicallyConsistent}(\mathcal{M}_n) \not\Rightarrow \text{AllDimensionsPhysicallyReal}(\mathcal{M}_n) . \quad (829)$$

The physical interpretation of dimensions is an additional model question.

41.2 Coordinate dimensions do not become time

For coordinate component:

$$x^j , \quad (830)$$

V38/F18 retains:

$$x^j \not\equiv_{\text{type}} T_{\text{ITOF}}. \quad (831)$$

An additional coordinate dimension therefore does not establish:

$$\text{AdditionalCoordinateDimensionInModel} \not\Rightarrow \text{AdditionalCosmicTimeExists}. \quad (832)$$

Nor does a model containing several time-like coordinates establish several ITOF temporal extensions merely from its mathematical signature:

$$\text{MultipleTimelikeCoordinatesInModel} \not\Rightarrow \text{MultipleITOFTemporalExtensions}. \quad (833)$$

41.3 State-space dimension is not cosmic-stage multiplicity

A high-dimensional state space:

$$\Omega_A \quad (834)$$

may be required to represent the physical state of system A .

Its dimension does not determine the cardinality or order type of:

$$\mathcal{S}_C^{\text{tot}}. \quad (835)$$

Thus:

$$\dim(\Omega_A) = n \not\Rightarrow |\mathcal{S}_C^{\text{tot}}| = n. \quad (836)$$

The same distinction applies to:

$$\Xi_A, \quad \mathcal{Y}_P, \quad \mathcal{Z}_{AB,P}, \quad (837)$$

and other application-level spaces.

41.4 Coordinate transformations

For:

$$x' = \Phi(x), \quad (838)$$

the transformation changes the mathematical representation, not the universal cosmic ordered pair. Thus:

$$x' = \Phi(x) \not\Rightarrow \text{ITOFTimeTransformed}. \quad (839)$$

41.5 Fixed coordinate does not establish physical stasis

For:

$$s_1, s_2 \in I_A \quad (840)$$

with:

$$s_1 \prec_C s_2, \quad (841)$$

selected coordinate equality:

$$x_P(A; s_1) = x_P(A; s_2) \quad (842)$$

does not establish:

$$x_P(A; s_1) = x_P(A; s_2) \not\Rightarrow X_A(s_1) = X_A(s_2). \quad (843)$$

Under UCC, the selected coordinate equality leaves the governing actual-change consequence unchanged:

$$x_P(A; s_1) = x_P(A; s_2) \wedge s_2 \in I_A \wedge \text{UCC} \implies \text{PhysReal}_A^+(s_2). \quad (844)$$

A system can remain at the same selected spatial coordinate while undergoing physical change.

41.6 General representation rule

For any mathematical representation:

$$\mathcal{R}_M(A), \quad (845)$$

V38/F18 adopts:

$$\text{Represents}_M(\mathcal{R}_M(A), A) \not\Rightarrow \mathcal{R}_M(A) \equiv_{\text{type}} A. \quad (846)$$

Likewise:

$$\text{RepresentsTimeRelatedRecords}_M(q) \not\Rightarrow q \equiv_{\text{type}} T_{\text{ITOF}}. \quad (847)$$

This rule unifies the treatment of:

$$\begin{aligned} &\text{coordinates, state vectors, metrics, proper-time functionals,} \\ &\text{higher-dimensional spaces, clock readings, statistical estimators,} \\ &\text{and model-evolution parameters.} \end{aligned} \quad (848)$$

42. Foundational Scope and Limits of ITOF V38/F18

42.1 Framework layers remain typed

V38/F18 distinguishes the temporal foundation from physical realization, identity, causation, observation, operational metrics, application physics, and empirical bridge structures. Schematically,

$$\begin{aligned} \mathfrak{L}_{38} = &\{\text{Temporal, PhysicalRealization, IdentityLifecycle, Causation}\} \\ &\cup \{\text{Observation, OperationalMetrics, ApplicationPhysics, EmpiricalBridges}\}. \end{aligned} \quad (849)$$

Membership in one framework does not make these layers definitionally identical or logically interchangeable. The layer distinction is a type distinction, not a claim of dependency isolation: realized physical change supplies the constitutive non-null semantics of admitted stages, while independently warranted physics supplies the dynamics of that change.

42.2 Minimal temporal core

The formal time definition is

$$T_{\text{ITOF}} = (\mathcal{S}_C^{\text{tot}}, \prec_C) \quad (850)$$

subject to

$$\begin{aligned}
& \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \\
& \iff [\mathcal{S}_C^{\text{tot}} \neq \emptyset] \wedge \text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) \\
& \quad \wedge \forall s \in \mathcal{S}_C^{\text{tot}} \text{ RealizedChangeStage}_C(s) \\
& \quad \wedge \exists r \in \mathcal{S}_C^{\text{tot}} \exists t \in \mathcal{S}_C^{\text{tot}} (r \prec_C t).
\end{aligned} \tag{851}$$

The members of $\mathcal{S}_C^{\text{tot}}$ are formal stage expressions of realized physical change in the one universal cosmic succession. Temporal admissibility excludes a singleton with no earlier–later relation while remaining neutral about finite versus unbounded future extent. Each stage member is the formal expression of objectively realized physical change within the governing earlier–later succession and is not an independent temporal container, physical location, or additional entity behind that expression. The ordered pair contains no physical-state profile, causal-source set, measurement rule, clock output, metric, or application dynamics.

The extent of the complete succession is deliberately not fixed by temporal admissibility. In particular,

$$\text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \not\Rightarrow \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C), \tag{852}$$

and the converse is also insufficient because non-termination alone does not supply realized-change stage semantics or strict ordering.

42.3 Three non-interchangeable foundational roles

The governing distinction is

$$\begin{aligned}
T_{\text{ITOF}} : & \quad \begin{array}{l} \text{universal ordered extension of objectively realized} \\ \text{physical change} \end{array}, \\
\text{CMA} : & \quad \begin{array}{l} \text{objective common-stage co-presence of the complete then-realized} \\ \text{qualified physical-system population} \end{array}, \\
\text{UCC} : & \quad \begin{array}{l} \text{continuing actual physical change without admitted stasis} \\ \text{in every qualified physical system throughout its realized identity range} \end{array}.
\end{aligned} \tag{853}$$

The temporal role fixes stage realization and the designated earlier–later order. The formal cosmic-stage domain architecture excludes private ITOF stage domains. CMA supplies objective common-stage co-presence of the complete then-realized qualified population, while UCC supplies system-specific physical-change continuity throughout realized identity ranges. Consequently,

$$T_{\text{ITOF}} \not\equiv_{\text{def}} \text{CMA}, \quad T_{\text{ITOF}} \not\equiv_{\text{def}} \text{UCC}, \quad \text{CMA} \not\equiv_{\text{def}} \text{UCC}. \tag{854}$$

No statement supplies a dynamical law merely by belonging to the foundation.

42.4 Foundational consequence of stage admissibility

Minimal physical non-nullness is constitutive of admitted stage meaning:

$$\text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \implies \forall s \in \mathcal{S}_C^{\text{tot}}, \quad \mathcal{B}_\Delta(s) \neq \emptyset. \tag{855}$$

This is not container language: it excludes assigning a cosmic-stage symbol to complete absence of physical change. The stagewise equivalent of UCC strengthens the statement to $\mathcal{B}_\Delta(s) = \mathcal{S}_{\text{phys}}(s)$ for every admitted stage. The governing UCC actual-change clause requires that complete qualified-system actual-change coverage; one-common-stage unity for the complete then-realized qualified population is already fixed by the global-stage architecture.

42.5 Limits of the foundation

Time, stage realization, CMA, UCC, and the optional non-termination condition do not by themselves specify a Hamiltonian, field equation, constitutive law, transition probability, universal change magnitude, clock response, signal law, or observable residual. Such quantities require independently warranted physical and measurement structures. Likewise, absence of an observed difference is not proof that physical change has ceased. Because the target, apparatus, record-bearing systems, observer, and laboratory/reference systems are themselves within the changing physical domain when qualified, an observed manifestation is produced and accessed through an internal physical chain; it does not by itself identify the exact cosmic stage or its absolute order position.

43. Core Commitments and Logical Status

The governing commitments are:

- (1) **Temporal referent and realized-change stage meaning.** $T_{\text{ITOF}} = (\mathcal{S}_C^{\text{tot}}, \prec_C)$. A written stage symbol designates an admitted member of the formal cosmic-stage domain; that member of the formal cosmic-stage domain is the formal expression of realized physical change and its place within the one universal earlier–later cosmic succession. Neither notation nor the member of the formal cosmic-stage domain is an independently existing physical stage object, ordering-position entity, temporal container, physical state, change packet, clock reading, metric interval, coordinate, or causal agent.
- (2) **Designated objective orientation, strict ordering, and non-reversal of the governing cosmic succession.** $\prec_C$ denotes the governing earlier–later relation. Strict Cosmic Ordering requires that designated relation to be a strict total order. A later realization remains later even if its declared physical state equals or recurs to an earlier state; state recurrence is not stage recurrence.
- (3) **Scientific openness of complete cosmic extent.** V38/F18 does not assert whether the complete future succession terminates or is unlimited. The condition

$$\text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \iff \forall s \in \mathcal{S}_C^{\text{tot}} \exists t \in \mathcal{S}_C^{\text{tot}} (s \prec_C t) \quad (856)$$

is a conditional cosmological premise when independently adopted, not a constituent of temporal admissibility.

- (4) **One-global-stage architecture and Cosmic Moment Axiom.** V38/F18 constitutively adopts one universal formal domain of cosmic stages for all qualified physical-system identities and excludes system-private stage domains. The identity ranges $I_A \subseteq \mathcal{S}_C^{\text{tot}}$ and stage populations articulate identity-stage incidence within that adopted formal cosmic-stage domain; they do not establish objective collective co-presence. The primitive meaning-fixed relation $\text{CosmicCoPresence}_C$ supplies the type in which that additional ontological claim

is stated. CMA independently requires objective co-presence of the complete then-realized qualified population at the same common cosmic stage. UCC independently requires every qualified system in that population to realize its own actual change there. No synchronization construction or private-stage identification is introduced.

- (5) **Universal Change Continuity.** UCC requires $\text{PhysReal}_A^+(s)$ for every qualified A and every $s \in I_A$. Its continuity means absence of complete physical-system stasis throughout the realized identity range; it is non-metric and does not itself select the system's dynamical law. Under the governing global-stage definitions, UCC is independent of CMA common-stage co-presence condition while remaining definitionally distinct.
- (6) **Cosmic physical totality, systems, factors, and granularity.** The physical universe denotes $\mathfrak{U}_C^{\text{phys}}$, the physical totality of system identities and physically realized physical factors; it is neither a physical container nor a single physical-system identity. Physical-system status is objective, while application-level individuation is fixed relative to a physically warranted class and organizational level. Simple systems need not be composite. Composite qualification requires physically warranted interconnection and coherence; ending or failure of a constituent does not by itself end the composite identity.
- (7) **Identity and lifecycle.** Identity-Realization Convexity, AFB, PIECP, conditional successor attribution, and optional UEIE retain distinct scopes. AFB constrains the least member of an identity range within the common cosmic-stage domain; it neither introduces a private stage nor marks the onset of physical change. AFB and UEIE are not derived from the governing temporal/CMA realization core; UEIE applies only when universal eventual identity ending is explicitly adopted. A terminal identity stage is the end of that identity range, not automatically a terminal cosmic stage. Identity ending does not itself require a successor. Where an ending transformation physically produces a genuinely new identity, the direct-successor relation fixes the required production, formation, and numerical-distinction conditions; absorption by a pre-existing persisting identity can instead end the absorbed system without creating a successor.
- (8) **Physical causation.** CRP separately requires actual physical causal contributors for actual physical change. Time, ordering, stage unity, and UCC are not causal-source classes.
- (9) **Observation and empirical discipline.** The sample or target, apparatus, detector, record-bearing system, observer, and laboratory or reference system remain physical systems where they satisfy the governing system criteria, and under UCC they continue changing throughout their realized identity ranges. The observation chain is therefore internal to the same cosmic succession and supplies no changeless external stage marker. Clock readings, proper-time functionals, coordinates, and metric intervals are physical or mathematical operational constructions, not the ITOF temporal referent. Prediction separation requires independently warranted physical provenance; ontological difference alone does not manufacture a residual.

44. Integrated Dependency Architecture

44.1 Temporal branch

The constructional dependency is

$$\langle \mathcal{S}_C^{\text{tot}}, \prec_C \rangle \overset{\text{definition}}{\rightsquigarrow} T_{\text{ITOF}}, \quad (857)$$

with

$$\begin{aligned}
& \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \\
& \implies [\mathcal{S}_C^{\text{tot}} \neq \emptyset] \wedge \text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) \\
& \quad \wedge \forall s \in \mathcal{S}_C^{\text{tot}} \text{ RealizedChangeStage}_C(s) \\
& \quad \wedge \exists r \in \mathcal{S}_C^{\text{tot}} \exists t \in \mathcal{S}_C^{\text{tot}} (r \prec_C t).
\end{aligned} \tag{858}$$

The designated earlier–later semantics is fixed independently of the strict-order axiom. The explicit earlier–later pair supplies only temporal non-degeneracy; it does not imply unlimited continuation. Realized-change stage semantics supplies physical non-nullness without supplying complete physical system coverage or a dynamical law. Cosmic non-termination is a separate optional cosmological condition.

44.2 Physical-system, population, CMA, and UCC branches

At the governing ontic level,

$$\langle \text{PhysicalSystem}, \text{ExistsAs} \rangle \overset{\text{dep}}{\rightsquigarrow} \langle \mathcal{U}_{\text{phys}}, I_A, \mathcal{S}_{\text{phys}}(s) \rangle. \tag{859}$$

Temporal stage admissibility then yields CSPP as a population corollary. The one-global-stage architecture fixes the common formal cosmic-stage domain before CMA is applied, but objective collective co-presence remains CMA’s independent burden. UCC states complete system-specific actual-change realization systemwise across identity ranges; by the stage-population definition the same UCC content can be re-indexed stagewise. That quantifier conversion concerns UCC only and does not derive CMA; it is shown in Appendix 53.

44.3 Causal branch

The UCC condition states physical-change actuality but does not type or supply causal contributors. CRP is separate:

$$\text{UCC} \wedge \text{CRP} \implies \forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A, \quad \mathcal{C}_A^{\text{act}}(s) \neq \emptyset. \tag{860}$$

No temporal symbol, CMA relation, or UCC predicate is thereby promoted into a physical causal source.

44.4 Identity and lifecycle branch

Identity qualification precedes application-level persistence, formation, ending, and successor attribution. For a protocol P , admissible application requires the prospective conditions of Eq. (198); a specific attribution additionally requires Eq. (200). AFB fixes the least member of each identity range within the common cosmic-stage domain. Under UCC, actual physical change is realized at that member and at every other admitted member of the range. Ending together with UCC therefore implies actual physical-change realization at the ending boundary. Optional UEIE remains independent of UCC and is not part of the governing core; ending does not by itself entail a direct successor; successor attribution is conditional on genuine new-identity production, while optional UEIE independently determines whether every qualified identity ends.

44.5 Application and observation branch

A physical prediction depends on declared model inputs, laws, parameter provenance, and model-output bridges. Observation additionally depends on acquisition, calibration, comparison, and uncertainty structures. Therefore

$$\text{ApplicationModelFailure} \not\Rightarrow \text{ITOFFoundationRejected}. \quad (861)$$

A foundation-level conclusion requires an identifiable bridge from the targeted foundational statement to the failed observable. Under identical complete physical-to-observable specifications, ontological difference alone produces no prediction separation.

44.6 Direct derivations under the current architecture

From Strict Cosmic Ordering,

$$r \prec_C s \implies \neg(s \prec_C r). \quad (862)$$

Exact or equivalent state recurrence does not change that ordering:

$$r \prec_C s \wedge X_A(r) = X_A(s) \implies r \neq s \wedge \neg(s \prec_C r). \quad (863)$$

From temporal stage semantics,

$$\text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \implies \text{CSPP} \wedge \forall s \in \mathcal{S}_C^{\text{tot}} \mathcal{B}_\Delta(s) \neq \emptyset. \quad (864)$$

From the optional Non-Terminating Cosmic Succession condition,

$$\text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \implies \nexists g \in \mathcal{S}_C^{\text{tot}} \text{Greatest}_{\prec_C}(g). \quad (865)$$

A nonempty strict total order with that additional non-termination condition is infinite, so the correct conditional cardinality statement is

$$\begin{aligned} &\text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \\ &\wedge \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \implies \text{Infinite}(\mathcal{S}_C^{\text{tot}}). \end{aligned} \quad (866)$$

From temporal admissibility together with UCC,

$$\text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \wedge \text{UCC} \implies \forall s \in \mathcal{S}_C^{\text{tot}}, \quad \mathcal{B}_\Delta(s) = \mathcal{S}_{\text{phys}}(s) \neq \emptyset. \quad (867)$$

The common formal cosmic-stage domain already supplies one common formal stage domain, while CMA independently supplies objective common-stage co-presence for that complete population. These derivations supply no Hamiltonian, causal law, metric scale, or observable beyond their declared premises.

45. Core Counterconditions

45.1 Scope and countercondition discipline

The direct contraries of the core foundational commitments are distinguished from identity-level, causal, formation, ending, application-model, and empirical failure conditions, which retain their

separately typed definitions.

Three levels must remain distinct:

$$\text{LogicalNegation}(P) \not\equiv_{\text{def}} \text{PhysicalFailureRealization}(P) \not\equiv_{\text{def}} \text{EmpiricalNonConfirmation}(P). \quad (868)$$

Failure to detect a predicted quantity is not by itself the logical negation of a foundational commitment:

$$\text{FormalCountercondition}(F) \not\equiv_{\text{def}} \text{FailureToObserve}(F). \quad (869)$$

45.2 Temporal-extension countercondition

Failure of temporal admissibility is

$$\neg \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \quad (870)$$

and, by definition, occurs if the stage domain is empty, the designated relation fails to be a strict total order, at least one admitted stage fails to denote an actual physical-change realization, or the admitted domain contains no nontrivial earlier-later pair:

$$\begin{aligned} & \neg \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \\ & \iff [\mathcal{S}_C^{\text{tot}} = \emptyset] \vee \neg \text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) \\ & \quad \vee \exists s \in \mathcal{S}_C^{\text{tot}} \neg \text{RealizedChangeStage}_C(s) \\ & \quad \vee \neg \exists r \in \mathcal{S}_C^{\text{tot}} \exists t \in \mathcal{S}_C^{\text{tot}} (r \prec_C t). \end{aligned} \quad (871)$$

A relabeling or coordinate transformation does not constitute reversal of the governing order when it preserves Eq. (27).

45.3 Contrary to the optional non-termination condition

Where the conditional cosmological premise is under consideration, Strict Cosmic Ordering makes its direct contrary the existence of a greatest admitted stage:

$$\begin{aligned} \text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) & \implies \left[\neg \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \right. \\ & \left. \iff \exists g \in \mathcal{S}_C^{\text{tot}} \forall t \in \mathcal{S}_C^{\text{tot}} (t = g \vee t \prec_C g) \right]. \end{aligned} \quad (872)$$

This is not itself a failure of temporal admissibility. Nor is either side established merely by a finite observational gap, failure to receive a signal, lack of a record, or non-detection of a selected observable.

45.4 Countercondition to the derived CSPP population principle

$$\neg \text{CSPP} \iff \exists s \in \mathcal{S}_C^{\text{tot}} : \mathcal{S}_{\text{phys}}(s) = \emptyset. \quad (873)$$

Because governing stage admissibility requires every admitted stage to represent actual physical change by a qualified system, $\neg \text{CSPP}$ is a consequence of failure of the governing stage semantics rather than an independent foundational countercondition.

45.5 Countercondition to CMA

The direct formal contrary to CMA is failure of objective common-stage co-presence for the complete then-realized qualified population at least one admitted stage:

$$\neg \text{CMA} \iff \exists s \in \mathcal{S}_C^{\text{tot}} : \neg \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s). \quad (874)$$

This contrary is distinct from complete physical non-change of a realized system, which is the direct contrary to UCC.

45.6 Countercondition to UCC

$$\neg \text{UCC} \iff \exists A \in \mathcal{U}_{\text{phys}} \exists s \in I_A : \text{NC}_A^{\text{phys}}(s). \quad (875)$$

This means that a qualified identity remains realized at s while the UCC actual physical-change condition fails for that physical system. It does not imply that the cosmic succession terminates:

$$\neg \text{UCC} \not\Rightarrow \neg \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C). \quad (876)$$

Nor does non-detection of change establish $\text{NC}_A^{\text{phys}}(s)$.

45.7 Application Failure Is Not a Core Contrary

Failure of a declared application model warrants rejection or restriction of that model on the tested domain. It does not automatically negate temporal admissibility, CSPP, CMA, UCC, or CRP:

$$\text{ApplicationModelRejectedOrRestricted}(M, D) \not\Rightarrow \text{ITOFFoundationRejected}. \quad (877)$$

A foundation-level conclusion requires an independently warranted and identifiable dependency chain from the targeted foundational premise to the failed observable.

46. Countercondition Register

The CMA contrary below concerns failure of objective common-stage co-presence. The UCC contrary separately concerns complete physical non-change of a realized qualified system at an admitted stage.

$$\begin{aligned}
\neg \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) &\iff [\mathcal{S}_C^{\text{tot}} = \emptyset] \vee \neg \text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) \\
&\vee \exists s \in \mathcal{S}_C^{\text{tot}} \neg \text{RealizedChangeStage}_C(s) \vee \neg \exists r \in \mathcal{S}_C^{\text{tot}} \exists t \in \mathcal{S}_C^{\text{tot}} (r \prec_C t), \\
\text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) &\implies \left[\neg \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \right. \\
&\iff \left. \exists g \in \mathcal{S}_C^{\text{tot}} \forall t \in \mathcal{S}_C^{\text{tot}} (t = g \vee t \prec_C g) \right], \\
\neg \text{CSPP} &\iff \exists s \in \mathcal{S}_C^{\text{tot}} : \mathcal{S}_{\text{phys}}(s) = \emptyset, \\
\neg \text{CMA} &\iff \exists s \in \mathcal{S}_C^{\text{tot}} : \neg \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s), \\
\neg \text{UCC} &\iff \exists A \in \mathcal{U}_{\text{phys}} \exists s \in I_A : \text{NC}_A^{\text{phys}}(s).
\end{aligned} \tag{878}$$

47. Mass-Defect and Clock-Response Program

47.1 Status and physical provenance

The mathematical-form-neutral dynamics and bridge architecture admits physical models whose governing laws have independent physical provenance. A quantitative atomic-clock response branch instantiates that architecture based on the internal-energy mass defect and weak gravitational coupling. The branch is denoted

$$\mathfrak{Q}_{\text{MD}} \tag{879}$$

and has the status

$$\text{Status}(\mathfrak{Q}_{\text{MD}}) = \text{ApplicationLevelPhysicalModelBranch}. \tag{880}$$

The branch is a physical model instantiation, not itself a measurement bridge. Its independently specified inputs enter the model-input layer, its Hamiltonian or response law belongs to the dynamics layer, its calculated fractional shifts belong to the prediction domain, and comparison with experimental records occurs only through the declared measurement and empirical-assessment layers. It is not derived from the temporal definition, CMA, or UCC. Its physical input is independently sourced from mass-energy equivalence, atomic transition physics, and the equality of inertial and gravitational mass in the weak-field model used below. Mass-defect formulations of atomic-clock shifts have been developed independently in the atomic-clock literature [15, 16].

Accordingly,

$$\mathfrak{Q}_{\text{MD}} \not\equiv_{\text{type}} T_{\text{ITOF}}. \tag{881}$$

The program predicts physical clock-transition quantities; comparison with record differences belongs to the declared measurement and empirical-assessment layers. It does not redefine the entity denoted by time.

For application-level derivability statements below, let $\Gamma_{38}^{\text{fund}}$ denote the conjunction of the governing V38/F18 foundational commitments actually invoked by the declared application. This premise shorthand is distinct from the framework-level tuple $\mathfrak{F}_{38}$ defined in Eq. (8) and from all application-specific physical assumptions. If a narrower premise set is used, its scope must be declared explicitly rather than inferred from the symbol.

47.2 Two-level clock physical system and mass-defect relation

Consider a clock physical system with internal states $|g\rangle$ and $|e\rangle$, unperturbed energies $E_g^{(0)}$ and $E_e^{(0)}$, and unperturbed angular transition frequency

$$\hbar\omega_0 = E_e^{(0)} - E_g^{(0)}. \quad (882)$$

Let the corresponding rest masses be M_g and M_e . Mass-energy equivalence gives

$$M_e - M_g = \frac{\hbar\omega_0}{c^2}. \quad (883)$$

The difference is a physical mass defect associated with the different internal energies of the same clock physical system. It is not a difference of times or cosmic stages.

47.3 Weak gravitational physical-response law

Let $\phi(\mathbf{r})$ be a weak classical gravitational potential over the declared experimental domain, with $|\phi|/c^2 \ll 1$, defined relative to a declared fixed reference-potential convention for the adopted weak-field model. Only potential differences enter the operational clock-comparison predictions; no undeclared absolute potential zero is assigned physical significance here. Under equality of inertial and gravitational mass, the physical energy assigned to internal state $j \in \{g, e\}$ is

$$E_j(\phi) = M_j c^2 + M_j \phi = M_j c^2 \left(1 + \frac{\phi}{c^2}\right). \quad (884)$$

Using Eq. (883), the transition frequency becomes

$$\omega(\phi) = \frac{E_e(\phi) - E_g(\phi)}{\hbar} = \omega_0 \left(1 + \frac{\phi}{c^2}\right). \quad (885)$$

For two locations $\mathbf{r}_1$ and $\mathbf{r}_2$, define the model fractional response relative to the unperturbed transition frequency by

$$y_{12}^{\text{MD}} := \frac{\omega(\phi_1) - \omega(\phi_2)}{\omega_0} = \frac{\phi_1 - \phi_2}{c^2}. \quad (886)$$

This is a physical transition-frequency relation. No proper-time functional, metric interval, clock-defined time, or stage-count magnitude occurs in its derivation. The benchmark observable is conventionally reported relative to a local clock frequency rather than ω_0 ; within the retained weak-field order, replacing the denominator by that local reference changes only terms beyond c^{-2} and therefore does not alter the benchmark predictions below.

For a sufficiently small vertical separation Δh , assume that the declared local potential profile is twice differentiable on the interval between h and $h + \Delta h$. Define the signed local potential gradient

$$g_h(h) := \frac{\partial \phi}{\partial h}(h), \quad (887)$$

which has dimensions of acceleration. Taylor's theorem gives, for some ξ between h and $h + \Delta h$,

$$\phi(h + \Delta h) - \phi(h) = g_h(h) \Delta h + \frac{1}{2} \frac{\partial^2 \phi}{\partial h^2}(\xi) (\Delta h)^2. \quad (888)$$

The sign of g_h is fixed by the declared vertical coordinate. Where the quadratic remainder is

negligible on the stated domain, the retained leading local prediction is

$$y_h^{\text{MD}} = \frac{g_h \Delta h}{c^2}, \quad \kappa_h^{\text{MD}} := \frac{y_h^{\text{MD}}}{\Delta h} = \frac{g_h}{c^2}. \quad (889)$$

The coefficient is not fitted to the clock outcome in the benchmark protocol; it is fixed by the independently supplied local potential gradient and the exact SI value of c .

47.4 Record model and independently controlled systematics

A measured clock comparison generally contains physical contributions beyond the weak gravitational response. For a declared protocol P , write

$$y_{12}^{\text{obs}} = y_{12}^{\text{MD}} + \sum_{k=1}^K s_{k,12} + \varepsilon_{12}, \quad (890)$$

where $s_{k,12}$ denotes a separately characterized differential physical systematic contribution and ε_{12} denotes the residual stochastic record term under the declared acquisition model. Depending on the clock class, the systematic family may include Zeeman, Stark, black-body-radiation, density, lattice, motional, link, and calibration contributions. The membership of that family and the associated correction and uncertainty models are protocol- and physical-system-specific.

A benchmark claim using a corrected published result requires

$$\begin{aligned} \text{BenchmarkAdmissible} \implies & \text{InputsExternallySpecified} \\ & \wedge \text{SystematicCorrectionsDeclared} \\ & \wedge \text{UncertaintyDeclared}. \end{aligned} \quad (891)$$

No unreported adjustment of g_h , Δh , or the coefficient in Eq. (889) is permitted after inspection of the target clock result.

47.5 Benchmark A: 0.33-m aluminium-ion clock comparison

Status: the clock result below is an externally reported measurement; the V38/F18 comparison value is calculated from independently supplied published inputs under the declared weak-field model.

Chou et al. reported a height change of

$$\Delta h_A = 0.33 \text{ m} \quad (892)$$

and a measured fractional frequency change

$$y_A^{\text{obs}} = (4.1 \pm 1.6) \times 10^{-17} \quad (893)$$

in a comparison of two $^{27}\text{Al}^+$ optical clocks [14].

Using only the published nominal local value $g_{h,A} = 9.80 \text{ m s}^{-2}$ for the upward height coordinate, the height change, and the exact value of c , Eq. (889) gives

$$y_A^{\text{MD}} = \frac{(9.80)(0.33)}{c^2} = 3.5983 \times 10^{-17}. \quad (894)$$

Using the published quoted uncertainty as the benchmark standard deviation, the nominal standardized residual is

$$z_A := \frac{y_A^{\text{obs}} - y_A^{\text{MD}}}{1.6 \times 10^{-17}} = 0.314. \quad (895)$$

This is a published-input consistency benchmark, not a reconstruction of the raw clock record or its full covariance.

47.6 Benchmark B: millimetre-scale strontium clock gradient

Status: the observed gradients below are externally reported measurements, while the comparison value is a model calculation from the independently reported local gravitational acceleration and exact c .

Bothwell et al. reported a local vertical gravitational acceleration

$$a_B = -9.796 \text{ m s}^{-2} \quad (896)$$

for the coordinate convention of their vertically oriented ^{87}Sr optical-lattice-clock sample and a predicted weak-field fractional frequency gradient of approximately $-1.09 \times 10^{-19} \text{ mm}^{-1}$ [23]. Equation (889) gives directly

$$\kappa_B^{\text{MD}} = \frac{a_B}{c^2} (10^{-3} \text{ m/mm}) = -1.08995 \times 10^{-19} \text{ mm}^{-1}. \quad (897)$$

The same work reports a corrected campaign gradient

$$\kappa_{B,1}^{\text{obs}} = -9.8(2.3) \times 10^{-20} \text{ mm}^{-1} \quad (898)$$

and a corrected synchronous two-region determination

$$\kappa_{B,2}^{\text{obs}} = -1.28(27) \times 10^{-19} \text{ mm}^{-1}. \quad (899)$$

The corresponding nominal standardized residuals are

$$z_{B,1} = \frac{\kappa_{B,1}^{\text{obs}} - \kappa_B^{\text{MD}}}{2.3 \times 10^{-20}} = 0.478. \quad (900)$$

$$z_{B,2} = \frac{\kappa_{B,2}^{\text{obs}} - \kappa_B^{\text{MD}}}{2.7 \times 10^{-20}} = -0.704. \quad (901)$$

The two reported determinations are not combined here as statistically independent measurements. Each is used only as a separate consistency check against the physical-response prediction with its response coefficient fixed by externally supplied physical inputs.

47.7 Cross-system benchmark meaning

The aluminium-ion and strontium benchmarks involve different atomic clock physical systems, different apparatuses, and different local gravitational fields. Under the mass-defect response law, physical-system independence concerns the response coefficient conditional on the same local physical potential gradient. For a physical-system class A realized at location $\mathbf{r}$,

$$\kappa_h^{(A)}(\mathbf{r}) = \frac{g_h(\mathbf{r})}{c^2} \quad (902)$$

for every physical-system class to which the stated physical assumptions apply. Thus the law does not require numerically identical gradients in laboratories with different g_h ; it requires the same fractional response per unit local potential difference. The published benchmark values above are consistent with that conditional physical-system independence relation at their quoted precision.

This result warrants only the bounded claim

$$\text{MassDefectClockResponseBenchmarkRecovered}(D_{\text{Al}^+}, D_{\text{Sr}}). \quad (903)$$

It does not establish UCC, CMA, the ITOF temporal definition, or any universal claim outside the tested physical domains.

47.8 Benchmark recovery is not relativistic discrimination

The leading weak-field relation in Eq. (886) coincides with the standard gravitational clock-shift relation through the retained order c^{-2} . Let the superscript (2) denote the prediction truncated consistently through that order. On the same physical inputs and benchmark domain,

$$\mathbf{y}_{\text{MD}}^{(2),P,D} = \mathbf{y}_R^{(2),P,D}. \quad (904)$$

No equality of uncalculated higher-order terms follows from this relation. Consequently,

$$\text{BenchmarkRecovered} \not\Rightarrow \text{FoundationalDiscrimination}(\text{ITOF}, \text{Relativity}). \quad (905)$$

The quantitative importance of $\mathfrak{Q}_{\text{MD}}$ is different: it supplies an independently sourced physical route from atomic internal-energy structure and external physical conditions to clock records without identifying the record difference with a difference in T_{ITOF} .

47.9 Hamiltonian physical-system extension for confined-ion motion

The weak-field scalar benchmark can be extended to confined-ion motion without altering the temporal definition. For this purpose V38/F18 adopts, as an independently sourced application model, the leading internal–external Hamiltonian structure derived for a charged composite clock physical system in external electromagnetic and weak gravitational fields [16]. In the notation used here, the relevant decomposition is

$$\hat{H} = \hat{H}_{\text{com}} + \hat{H}_{\text{int}} + \hat{H}_{\text{at-emf}} + \hat{H}_{\text{metric}} + \hat{H}_{\text{MD}}. \quad (906)$$

The diagonal mass-defect coupling between center-of-mass and internal degrees of freedom is

$$\hat{H}_{\text{MD}} = \left(M\phi(\hat{\mathbf{R}}) - \frac{\hat{\mathbf{P}}^2}{2M} \right) \otimes \frac{\hat{H}_{\text{int}}^{(0)}}{Mc^2}. \quad (907)$$

Here M is the physical-system rest mass used in the external Hamiltonian, $\hat{\mathbf{R}}$ is its center-of-mass position, $\hat{\mathbf{P}}$ is the mechanically coupled center-of-mass momentum, and $\hat{H}_{\text{int}}^{(0)}$ is the unperturbed internal Hamiltonian. In the stationary nondegenerate internal-state regime treated by the cited derivation, the metric term has no diagonal energy contribution at the retained order; the leading diagonal internal–external clock coupling is then carried by Eq. (907).

Define the external kinematic–gravitational coupling operator

$$\widehat{K}_{\text{ext}} := \phi(\widehat{\mathbf{R}}) - \frac{\widehat{\mathbf{P}}^2}{2M^2}. \quad (908)$$

For a two-level transition satisfying Eq. (882), first-order diagonal perturbation theory in c^{-2} gives the instantaneous fractional transition response

$$y_H(t) = \frac{1}{c^2} \text{Tr}_{\text{ext}} \left[\rho_{\text{ext}}(t) \widehat{K}_{\text{ext}} \right]. \quad (909)$$

For interrogation interval $[0, T]$, the corresponding cycle-averaged branch is

$$\bar{y}_H(T) := \frac{1}{Tc^2} \int_0^T \text{Tr}_{\text{ext}} \left[\rho_{\text{ext}}(t) \widehat{K}_{\text{ext}} \right] dt. \quad (910)$$

This expression contains the gravitational contribution through $\phi(\widehat{\mathbf{R}})$ and the motional second-order contribution through $\widehat{\mathbf{P}}^2$. It is an application-level perturbative physical response formula. If internal–external entanglement or additional relativistic terms are non-negligible in a selected experiment, the corresponding full Hamiltonian evolution must replace this reduced first-order expression.

47.10 Hamiltonian Content Does Not Create a Residual

The independently derived full trapped-ion Hamiltonian framework cited above provides the external–internal relativistic dynamics in electromagnetic and weak gravitational fields and is applied to Paul-trap effects including secular motion, micromotion, excess micromotion, and trap imperfections [16]. Within that broader framework, Eq. (907) is the retained leading diagonal internal–external mass-defect coupling under the stated approximation; the isolated displayed $\widehat{H}_{\text{MD}}$ term must not be read as, by itself, encoding every trap, field, micromotion, or imperfection contribution of the full derivation. The cited framework recovers the established relativistic frequency-shift content in its domain and does not thereby supply an additional ITOF-specific residual. Earlier mass-defect analyses had considered additional trapped-clock contributions [15]; those proposals are not promoted here to governing V38/F18 predictions.

Accordingly, the V38/F18 temporal core together with the established physical Hamiltonian does not supply an independently nonzero additional residual:

$$\left[\Gamma_{38}^{\text{fund}} \wedge \text{BaseHamiltonianSpecified} \left(\widehat{H}_{\text{base}} \right) \right] \not\Rightarrow \delta y_X \neq 0, \quad (911)$$

where $\widehat{H}_{\text{base}}$ denotes the independently warranted standard Hamiltonian for the declared physical system and apparatus. This is a dependency boundary, not a claim that every possible physical extension must have zero residual.

47.11 Hamiltonian benchmark C: reconstructed secular-motion shift

This benchmark reconstructs a published systematic correction from published modal inputs; it is neither an independent measurement nor an advance ITOF prediction.

A direct modal benchmark is supplied by the 2025 NIST $^{27}\text{Al}^+$ quantum-logic clock [17]. Its supplemental evaluation reports six secular modes with mode-specific fractional frequency shift

per motional quantum s_α , mean occupation $\bar{n}_\alpha$, and uncertainty $\sigma_{\bar{n},\alpha}$. For the reported modal model, define

$$y_{\text{sec}}^{\text{modal}} := \sum_{\alpha=1}^6 s_\alpha \left(\bar{n}_\alpha + \frac{1}{2} \right). \quad (912)$$

The factor $1/2$ retains the zero-point motional contribution. The published inputs are:

Mode	ν_α [MHz]	s_α [10^{-19}]	$\bar{n}_\alpha$	$\sigma_{\bar{n},\alpha}$	$s_\alpha(\bar{n}_\alpha + 1/2)$ [10^{-19}]
Axial COM	2.16	-0.95	8.22	0.48	-8.2840
Axial STR	3.75	-1.42	4.50	0.19	-7.1000
X COM	4.22	-1.77	5.68	0.49	-10.9386
X STR	3.48	-6.48	6.69	0.51	-46.5912
Y COM	5.37	-1.42	4.31	0.14	-6.8302
Y STR	4.75	-6.53	4.84	0.24	-34.8702

Therefore,

$$y_{\text{sec}}^{\text{modal}} = -114.6142 \times 10^{-19}. \quad (913)$$

Using only the reported occupation-number uncertainties and the published modal coefficients, the corresponding propagated uncertainty is

$$\sigma_{\text{sec}}^{(\bar{n})} = \left[\sum_{\alpha=1}^6 (s_\alpha \sigma_{\bar{n},\alpha})^2 \right]^{1/2} = 3.80135 \times 10^{-19}. \quad (914)$$

Rounding to the precision of the published clock evaluation gives

$$y_{\text{sec}}^{\text{modal}} = -(114.6 \pm 3.8) \times 10^{-19}, \quad (915)$$

which reproduces the reported secular-motion correction. This is a reconstruction of the published modal systematic model, not an independent experimental confirmation and not a foundational ITOF–relativity discrimination.

47.12 Independent nonstandard Hamiltonian residual family

A genuinely new residual requires an independently specified physical interaction beyond $\hat{H}_{\text{base}}$. Let

$$\hat{H}_{\text{test}} := \hat{H}_{\text{base}} + \lambda_X \hat{O}_X, \quad (916)$$

where $\hat{O}_X$ is a physically typed operator and λ_X has independent physical provenance. Their dimensions must be declared for each candidate so that $\lambda_X \hat{O}_X$ has units of energy. Thus the normalization of λ_X is not a free notational choice that can be changed after confronting data. In the perturbative diagonal regime, define

$$D_X(t) := \text{Tr}_{\text{ext}} \left[\rho_{\text{ext}}(t) (\langle e | \hat{O}_X | e \rangle - \langle g | \hat{O}_X | g \rangle) \right]. \quad (917)$$

After the internal-state matrix elements are taken, the bracketed difference in Eq. (917) is an operator on the external motional state space. The external trace therefore gives the state-dependent transition-energy contribution per unit λ_X . The induced cycle-averaged fractional

residual is then

$$\delta y_X(T) = \frac{\lambda_X}{\hbar\omega_0 T} \int_0^T D_X(t) dt. \quad (918)$$

No advance prediction follows unless the operator, coupling, physical-system state, apparatus parameters, domain, and acquisition bridge are fixed independently of the evaluation outcome. In particular,

$$\Gamma_{38}^{\text{fund}} \not\Rightarrow \lambda_X \neq 0. \quad (919)$$

The ITOF temporal ontology therefore cannot be used as a substitute for the missing physical derivation of a new interaction.

Let y_{base} denote the prediction derived from $\hat{H}_{\text{base}}$ in the same declared protocol. For a rival prediction y_R , model-level resolved separation requires

$$|y_{\text{base}} + \delta y_X - y_R| > \eta_*, \quad (920)$$

with the combined uncertainty structure and admissible bridge class fixed before evaluation. A foundational conclusion additionally requires the attribution and bridge-robust conditions of Section 25 and Section 36.

47.13 Forward quantum-motional test domain

Status: the numerical effects discussed here are externally sourced forward physical-model predictions used as a test domain for the bridge architecture; they are not derived from the temporal ontology.

Recent trapped-ion theory provides a further application domain in which the external motional state is genuinely quantum rather than a classical trajectory surrogate [18]. For a harmonically trapped clock physical system, let

$$\epsilon_m := \frac{\hbar\omega_m}{Mc^2}, \quad (921)$$

where ω_m is the motional angular frequency. The cited Hamiltonian model predicts, for the motional ground state,

$$y_{\text{vSODS}} = -\frac{\epsilon_m}{4}, \quad (922)$$

and for a squeezed motional state with squeeze parameter r , to the stated leading order,

$$y_{\text{sqSODS}} \simeq -\frac{\epsilon_m}{4} \cosh(2r). \quad (923)$$

The same model predicts a motion-clock entanglement signature in the Ramsey visibility. In its leading small-parameter form,

$$\mathcal{V} \simeq 1 - \frac{(\epsilon_m\omega_0 T)^2}{16} \sinh^2(2r). \quad (924)$$

For the $^{27}\text{Al}^+$ parameter example analyzed in the cited work, a 20-MHz trap, one-second evolution, and $r = 2.26$ give a predicted visibility of approximately 0.93, while the magnitude of the squeezing-associated fractional frequency shift is approximately 3.8×10^{-17} . These are external physical-model predictions and constitute a forward experimental domain for the V38/F18 bridge architecture.

Observation of such quantum-motional effects would test the corresponding Hamiltonian model. It would not by itself identify the proper-time quantity used in that model with the entity denoted

by time in ITOF:

$$\text{QuantumMotionalClockEffectObserved} \not\Rightarrow \tau \equiv_{\text{type}} T_{\text{ITOF}}. \quad (925)$$

47.14 Quantitative claim boundary

The program now contains a weak-field gravitational branch, a trapped-ion Hamiltonian physical-system branch, a modal reconstruction of a published secular-motion correction, and a forward quantum-motional application domain. None supplies a nonzero ITOF-specific interaction coefficient. The governing quantitative status is therefore

$$\begin{aligned} & \text{QuantitativePhysicalBridgeSpecified} \\ & \wedge \text{HamiltonianPhysicalSystemBranchSpecified} \\ & \wedge \text{BenchmarkRecoveryDemonstrated} \\ & \wedge \text{PublishedMotionalBenchmarkReconstructed} \\ & \wedge \neg \text{ITOFSpecificResidualDerived} \\ & \wedge \neg \text{FoundationSpecificPredictionSeparationDemonstrated}. \end{aligned} \quad (926)$$

The distinction between quantitative physical adequacy and foundational discrimination is preserved.

48. Predictive Separation Boundary

48.1 Claim boundary

The quantitative program has established physical benchmark recovery and a Hamiltonian physical-system branch, but neither result supplies a nonzero ITOF-specific residual. The next question is therefore narrower: under what conditions can a physically testable prediction differ from a rival prediction while the V38/F18 temporal definition remains unchanged?

Candidate interactions remain subject to the stated physical and inferential constraints. A candidate does not become a governing V38/F18 postulate merely because it would produce a measurable difference.

48.2 Non-Separation Under Identical Physics

Using the governing-premise shorthand $\Gamma_{38}^{\text{fund}}$ fixed in Section 47, let two application branches I and R be defined on the same evaluation domain D . For each branch $J \in \{I, R\}$, define the complete physical-to-observable specification

$$\begin{aligned} \mathfrak{S}_J^{P,D} := & \left(\text{PhysicalTarget}_J, \text{StatePreparation}_J, \text{PhysicalParameters}_J, \text{SystemBoundaries}_J, \right. \\ & \mathcal{B}_J^{\text{in}}, \text{Dyn}_J, \mathcal{B}_J^{\text{out}}, \text{AuxiliaryPhysicalPremises}_J, \\ & \left. \mathcal{B}_{J;P,D}^{\text{obs}}, \text{AcquisitionModel}_J, \text{Calibration}_J, \text{UncertaintyModel}_J \right). \end{aligned} \quad (927)$$

The temporal ontological interpretation is not a component of $\mathfrak{S}_J^{P,D}$. Define

$$\text{SamePhysicalSpecification}_{P,D}(I, R) \iff \mathfrak{S}_I^{P,D} = \mathfrak{S}_R^{P,D}. \quad (928)$$

The predicate therefore holds only when every declared component relevant either to the predicted record or to its empirical evaluation is held fixed across the typed encoding–dynamics–prediction–measurement chain. $\mathbf{y}_J^{P,D}$ denotes the declared predicted observable object: a numerical/vector prediction in a deterministic branch, a probability law or other distributional record object in a stochastic branch, or the declared quantum measurement-statistics object in a quantum branch. Equality of these objects does not assert identity of separately realized stochastic samples or individual measurement outcomes.

Proposition 48.1 (Physical-Prediction Non-Separation). If the only difference between the two branches is the temporal ontological interpretation while $\text{SamePhysicalSpecification}_{P,D}(I, R)$ holds, then no observable prediction separation follows from that ontological difference alone:

$$\text{SamePhysicalSpecification}_{P,D}(I, R) \implies \mathbf{y}_I^{P,D} = \mathbf{y}_R^{P,D}. \quad (929)$$

Consequently,

$$\Delta_{I:R}^{P,D} = 0, \quad \delta_{I:R}^{P,D} = 0, \quad (930)$$

where the second equality applies to the bridge-robust separation margin when the admissible bridge classes contain no physically distinct prediction branch.

Proof. By Eq. (928), the two branches have identical physical target, state preparation, physical parameters, system boundaries, model-input bridge, model dynamics, model-output bridge, auxiliary physical premises, measurement bridge, acquisition model, calibration, and uncertainty model on (P, D) . The identical dynamical and prediction chain evaluated on identical physical inputs therefore gives the same pre-observable prediction in both branches. Applying the identical measurement and acquisition specification gives the same declared predicted observable object—including the same probability law or quantum outcome-statistics object when the bridge is non-deterministic—so $\mathbf{y}_I^{P,D} = \mathbf{y}_R^{P,D}$. This equality is not an assertion that two independent stochastic realizations must return the same sample. Hence $\Delta_{I:R}^{P,D} = 0$. If the admissible bridge classes contain no physically distinct prediction branch, every admissible bridge pair yields zero prediction distance, so the infimum defining $\delta_{I:R}^{P,D}$ is also zero.

This is a dependency proposition. It does not add a dynamical law or assert empirical equivalence between ITOF and every relativistic physical theory.

By contraposition of Eq. (929), an observable prediction separation requires a difference in the complete physically operative specification:

$$\mathbf{y}_I^{P,D} \neq \mathbf{y}_R^{P,D} \implies \mathfrak{S}_I^{P,D} \neq \mathfrak{S}_R^{P,D}. \quad (931)$$

For a claimed novel physical prediction, the differing component must also be prediction-relevant and independently warranted. This condition is necessary, not sufficient. The V38/F18 temporal definition, CMA, and UCC do not by themselves specify such an additional physically operative difference.

48.3 Minimal stage-referenced preferred-frame candidate

A direct attempt to connect objective common-stage realization to a measurable clock response is to introduce, at application level, a physically specified preferred-stage rest frame. V38/F18 does not identify such a frame with the cosmic microwave background or with any coordinate system. For screening only, let $\mathbf{V}_n$ denote the laboratory velocity relative to a separately specified candidate stage-referenced frame and let $\hat{\mathbf{p}}$ be the physical-system momentum relative to the laboratory apparatus.

For a nonrelativistic physical system in this application-level screening model, define

$$\hat{\mathbf{v}}_n := \mathbf{V}_n + \frac{\hat{\mathbf{p}}}{M}. \quad (932)$$

For a spin-independent, parity-even response constructed only from this relative physical-system velocity and the scalar internal clock energy, the leading nonconstant rotational scalar is parameterized by

$$\hat{H}_{\text{SR}}^{(2)} := \xi_2 \hat{H}_{\text{int}}^{(0)} \frac{\hat{\mathbf{v}}_n^2}{c^2}. \quad (933)$$

Here ξ_2 is a dimensionless physical coupling. It is not fixed by the time definition:

$$\Gamma_{38}^{\text{fund}} \not\Rightarrow (\xi_2 \neq 0). \quad (934)$$

Expanding Eq. (933) gives

$$\hat{H}_{\text{SR}}^{(2)} = \xi_2 \hat{H}_{\text{int}}^{(0)} \left[\frac{V_n^2}{c^2} + \frac{2\mathbf{V}_n \cdot \hat{\mathbf{p}}}{Mc^2} + \frac{\hat{\mathbf{p}}^2}{M^2 c^2} \right]. \quad (935)$$

This decomposition separates a preferred-frame kinematic term, a motion-frame cross term, and a quantum or classical motional-energy term.

48.4 Phenomenological non-uniqueness of the quadratic candidate

A clock-frequency response proportional to V_n^2/c^2 belongs to the same phenomenological class as preferred-frame and Lorentz-symmetry-violation clock tests. Robertson–Mansouri–Sextl clock comparisons already constrain a quadratic time-dilation-violation coefficient at the level $|\alpha| \lesssim 1.1 \times 10^{-8}$ in the normalization used in that test framework [20]. Optical-clock comparisons also constrain orientation-dependent electron-sector Lorentz-violation coefficients at levels reaching approximately 10^{-21} for the reported combinations [21], and more general matter–gravity clock comparisons constrain additional SME coefficient combinations [22].

Therefore Eq. (933) is not a unique ITOF signature. Let $\alpha_{\text{vio}}^{\text{RMS}}$ denote the quadratic time-dilation-violation coefficient in the convention used for the clock-network bound of Ref. [20]. Under the conditional normalization

$$\xi_2 \equiv \alpha_{\text{vio}}^{\text{RMS}}, \quad (936)$$

the existing clock-network constraint gives the screening bound

$$|\xi_2| \lesssim 1.1 \times 10^{-8}. \quad (937)$$

This is a conditional phenomenological mapping, not an identification of ITOF with the RMS framework and not a claim that ITOF selects the preferred frame used in that analysis. The cited

RMS result directly constrains the corresponding leading observable quadratic preferred-frame response under this declared normalization. Extending the same ξ_2 to the motion-frame cross term and the motional $\hat{\mathbf{p}}^2$ term is a model assumption of the screened candidate Hamiltonian, not a separately measured operator-level bound. The quantum-motional estimates below are therefore conditional projections of that candidate under the stated shared-coefficient normalization.

48.5 Conditional quantum-motional scale

For one harmonic motional mode of angular frequency ω_m , the ground state satisfies

$$\left\langle \frac{\hat{\mathbf{p}}^2}{M^2} \right\rangle_0 = \frac{\hbar\omega_m}{2M}. \quad (938)$$

The corresponding magnitude of the quadratic stage-referenced quantum-motional fractional response is bounded by

$$|\delta y_{\text{SR},0}^{(2)}| \leq |\xi_2| \frac{\hbar\omega_m}{2Mc^2}. \quad (939)$$

For a squeezed state with squeeze parameter r , the phase-averaged momentum variance introduces the factor $\cosh(2r)$, giving

$$|\delta y_{\text{SR},\text{sq}}^{(2)}| \leq |\xi_2| \frac{\hbar\omega_m}{2Mc^2} \cosh(2r). \quad (940)$$

Using $^{27}\text{Al}^+$, $\omega_m = 2\pi \times 20$ MHz, $r = 2.26$, and the conditional bound in Eq. (937), the numerical screening values are

$$|\delta y_{\text{SR},0}^{(2)}| \lesssim 1.81 \times 10^{-26}, \quad (941)$$

and

$$|\delta y_{\text{SR},\text{sq}}^{(2)}| \lesssim 8.31 \times 10^{-25}. \quad (942)$$

Thus squeezing does not make this already constrained quadratic candidate a competitive source of a new clock-frequency residual at present optical-clock precision. The conclusion concerns the explicitly screened candidate, not every possible physical extension.

48.6 Higher-order preferred-stage scalar candidates

A formally possible next term is

$$\hat{H}_{\text{SR}}^{(4)} := \xi_4 \hat{H}_{\text{int}}^{(0)} \left(\frac{\hat{\mathbf{v}}_n^2}{c^2} \right)^2. \quad (943)$$

Such a term is not adopted as a prediction. The absence of the lower-order coefficient ξ_2 while $\xi_4 \neq 0$ requires an independent symmetry, selection rule, or microscopic mechanism. V38/F18 supplies none. Moreover, higher-order preferred-frame matter couplings belong generically to broader Lorentz-violation effective-field-theory searches, where operators of multiple mass dimensions and background tensors are already classified [19], rather than constituting a signature unique to ITOF. The quartic term is therefore retained only as a classification example and is not promoted to the predictive branch.

48.7 Coherence Alone Is Not a Valid Shortcut

A proposed residual depending directly on a state functional such as $\rho_{\text{off-diagonal}}$, a variance, or an expectation value inside the Hamiltonian would in general introduce state-dependent nonlinear dynamics unless it is derived from a state-independent operator and an independently specified physical interaction. Accordingly,

$$\text{DesiredQuantumOnlyResidual} \not\Rightarrow \text{AdmissibleLinearHamiltonianInteraction} . \quad (944)$$

If a term is instead written as an ordinary linear operator, for example through quadratic motional operators associated with an apparatus phase reference, its physical coefficient and phase reference require independent provenance. Such a term is then a generic physical interaction and does not become ITOF-specific by being evaluated on a squeezed state.

48.8 Complete-population coupling is not implied by stage-change

A different proposal would couple a local system directly to a functional of the complete common-stage population or of $\mathfrak{R}_C(s)$. A schematic expression would be

$$\hat{H}_A^{\text{pop}}(s) = g_A F(\mathfrak{R}_C(s)) \hat{O}_A. \quad (945)$$

CMA does not entail this interaction. Adopting it would add a new physical coupling law connecting one system to information about the complete population, whereas V38/F18 explicitly separates common-stage co-realization from physical interaction, signal accessibility, and causal determination. Such a law would therefore require a separately specified physical mediator or nonlocal dynamics and its own no-signalling, conservation, and causal analysis. It is not a minimal predictive consequence of the present framework.

48.9 Differential Structure for Foliation Couplings

A metric application could introduce a smooth stage-association scalar and a unit timelike normal, then construct expansion, shear, acceleration, or extrinsic-curvature tensors. V38/F18 itself does not require a differentiable stage parameter, a metric on $\mathcal{S}_C^{\text{tot}}$, adjacency, or topology. Consequently, terms depending on derivatives of a foliation field are not derivable from the bare temporal ordered pair. In particular:

$$\text{TemporalDefinition}_{\text{ITOF}} \not\Rightarrow \text{FoliationDerivativeStructuresSpecified} . \quad (946)$$

The unprovided structures include $\nabla_\mu n_\nu$, $K_{\mu\nu}$, θ_n , and $\sigma_{\mu\nu}$. They remain possible structures of an independently supplied spacetime model, but using them as a new physical interaction would constitute a substantially larger extension than the minimal clock-response program examined here.

48.10 Result of the minimal predictive search

The candidate screening produces the following bounded result:

$$\begin{aligned}
& \text{PhysicalPredictionNonSeparationEstablished} \\
& \wedge \text{QuadraticPreferredStageCandidateClassified} \\
& \wedge \text{QuadraticQuantumEnhancementInsufficientUnderExistingBound} \\
& \wedge \text{HigherOrderCandidateNotIndependentlyMotivated} \\
& \wedge \text{StateFunctionalShortcutRejected} \\
& \wedge \text{PopulationWideCausalCouplingNotDerivedFromCMA} \\
& \wedge \text{DifferentiableFoliationCouplingNotDerivedFromBareOrder} \\
& \wedge \neg \text{UniqueITOFSpecificHamiltonianOperatorDerived} .
\end{aligned} \tag{947}$$

This is a formal dependency-boundary result. It identifies where a genuinely new prediction must enter: through an independently warranted physical postulate or microscopic mechanism that changes the physical application model while remaining consistent with the established benchmark limits. No such mechanism is manufactured from temporal ontology alone.

49. Physical Research Program

Quantum fluctuation and entanglement program.

Future work may apply ITOF's existing type discipline to quantum fluctuation models and entangled physical systems by fixing the physical-system boundary, identifying which attributions of system-specific change are warranted by the applicable quantum dynamics, and separating physical correlations from detector records and reconstruction. This program does not modify the quantum state, Hamiltonian, Born rule, or entanglement correlations by definition. Any ITOF-specific observable difference would require an independently specified physical interaction or bridge that changes a prediction relative to an otherwise identical physical model.

49.1 Foundational completion is not completion of physical theory

V38/F18 develops a foundational temporal and physical-realization architecture and now includes the domain-specific quantitative mass-defect clock-response branch of Section 47.

That benchmark branch does not amount to a complete dynamics of all physical phenomena.

The distinction is:

$$\text{FoundationalArchitectureSpecified} \not\Rightarrow \text{CompletePhysicalTheoryOfNatureSpecified} . \tag{948}$$

In particular, the governing temporal definition

$$T_{\text{ITOF}} = \mathcal{E}_C = \left(\mathcal{S}_C^{\text{tot}}, \prec_C \right) \tag{949}$$

does not determine one universal law of system-specific physical change.

Likewise, the complete-population common-stage physical-realization profile

$$\mathfrak{R}_C(s) = (\mathcal{S}_{\text{phys}}(s), \mathfrak{X}_C(s), \mathfrak{D}_C(s), \mathfrak{G}_C(s)) \quad (950)$$

does not supply one universal equation transforming one such profile into another.

49.2 Open Problem 1: Domain-Specific Dynamics

For a declared class of physical systems $\mathcal{A}$ not already covered by the mass-defect clock-response benchmark, or for physical effects beyond that branch's declared validity domain, a major application problem is to derive or independently warrant a physical model

$$M_{\mathcal{A}} \quad (951)$$

with a sufficiently explicit typed application chain connecting system-specific physical inputs to model realizations, predictions, and records.

The required route is:

$$\begin{aligned} \text{DeclaredPhysicalSystems} &\longrightarrow \text{TypedPhysicalInputs} \\ &\longrightarrow \text{ModelEncoding} \\ &\longrightarrow \text{PhysicalDynamics} \\ &\longrightarrow \text{AdvancePrediction} \\ &\longrightarrow \text{MeasurementAndAcquisition} \\ &\longrightarrow \text{PhysicalRecord} . \end{aligned} \quad (952)$$

The response law must be established independently of the ITOF temporal definition.

No equation is accepted merely because it produces a desired interpretation of time.

49.3 Open Problem II: Realization across System Levels

The hierarchy relation

$$A \triangleleft_{\kappa, s} B \quad (953)$$

makes cross-level questions explicit without answering them universally.

Future physical work may investigate:

$$\begin{aligned} &\text{how subsystem change contributes to composite change,} \\ &\text{how composite constraints affect constituent change,} \\ &\text{how causal contributions are redistributed under changing boundaries,} \\ &\text{and how new numerical identities emerge from physical reorganization.} \end{aligned} \quad (954)$$

Any quantitative cross-level rule requires its own physical derivation.

Composition alone is insufficient.

49.4 Third open problem: population transformation

The stage-pair population descriptor

$$\mathfrak{P}_C^{\text{pop}}(r, s) \quad (955)$$

provides a general identity-level classification of persistence, formation, ending, and intermediate-only realization.

Future work may connect these sets to specific physical models of:

$$\begin{aligned} &\text{formation, decay, fusion, fission, reorganization,} \\ &\text{biological formation and ending, astrophysical transformation,} \\ &\text{chemical transformation, and other identity-changing physical processes.} \end{aligned} \quad (956)$$

No universal law of population conservation, one-to-one successorship, or successor nonemptiness is presupposed. An actual ending may produce zero, one, or several direct successors according to the physically warranted transformation and identity criteria.

49.5 Open Problem IV: Domain-Specific Directionality

The criterion-indexed descriptor $\mathfrak{A}_{A,\alpha}$ permits physical “arrows” to be studied without identifying them with time. Domain-specific applications must determine which state variables and comparison relations are physically warranted, whether alignment holds over a stated domain, and whether plateaus, recurrence, or criterion-relative reversals occur. No universal thermodynamic, developmental, decay-statistical, memory, record, or computational arrow is inferred from UCC alone.

49.6 Fifth open problem: operational metrics

V38/F18 defines the general operational architecture

$$m_P = \mathcal{M}_P^{\text{op}}(r_1, \dots, r_n; \kappa_P). \quad (957)$$

A major future task is to classify physically important metric constructions according to:

$$\begin{aligned} &\text{record source, calibration, comparison rule, model dependence,} \\ &\text{physical sensitivity, systematic effects, uncertainty, and predictive role.} \end{aligned} \quad (958)$$

The purpose is not to eliminate metric science.

It is to identify precisely what each metric measures or represents without transferring that quantity into the definition of time. The order-representation result in Eq. (37) further requires that any claimed metric interval specify the additional physical or mathematical structure that fixes its scale beyond bare earlier–later order.

49.7 Sixth open problem: physical-system-specific residual physics

The quantitative program in Section 47 now includes both weak-field gravity and an independently sourced trapped-ion Hamiltonian branch. It also reconstructs the published 2025 six-mode secular-motion correction. These results show that clock-system motion and confinement can be treated quantitatively without redefining time, but the established Hamiltonian does not itself generate an ITOF-specific residual.

Any stronger physical-system-specific program must therefore identify a physical interaction beyond the declared base Hamiltonian and specify

$$\mathfrak{M}_C^X = \left(\text{ClockSystemBoundary}, \hat{H}_{\text{base}}, \lambda_X \hat{O}_X, \text{StatePreparation}, \right. \\ \left. \text{ParameterProvenance}, \text{AcquisitionModel}, \right. \\ \left. \text{UncertaintyStructure}, \text{PredictionCriterion} \right). \quad (959)$$

The additional operator and coupling must be physically derived or independently warranted. A nonzero value may not be inferred from the ITOF temporal definition, CMA, UCC, or disagreement with a rival temporal ontology.

The quantum-motional branch of Eqs. (922)–(924) provides a near-term experimental domain for testing internal–external quantum clock dynamics while preserving this attribution boundary. The minimal candidate screening in Section 48 additionally shows that the simplest quadratic preferred-stage clock coupling is neither unique to ITOF nor rescued by squeezed-state enhancement under the existing clock-network bound. A stronger residual therefore requires a physically new mechanism rather than a relabeling of an already constrained preferred-frame coefficient.

49.8 Seventh open problem: prediction separation

A foundation-sensitive empirical program requires a domain D^* in which independently specified ITOF and relativistic application branches remain separated after the admissible bridge freedom has been propagated. In the notation of Section 36, the target condition is:

$$\delta_{I:R}^{P,D^*} > \eta_*, \quad (960)$$

with the bridge classes, covariance construction, and threshold fixed independently of the evaluation outcome. Such a separation creates empirical discriminatory potential that cannot be removed merely by choosing another already-admissible bridge realization.

Without it:

$$\text{FoundationalDisagreement} \not\Rightarrow \text{ObservableDiscrimination}. \quad (961)$$

This remains one of the principal unresolved physical tasks of the framework.

49.9 Eighth open problem: attribution to foundational commitments

Even where an ITOF-admissible application model and a relativistic model make distinct predictions, further work is required to determine whether the difference originates in:

$$\begin{aligned}
& \text{a foundational temporal commitment,} \\
& \text{a physical response law,} \\
& \text{a parameter choice,} \\
& \text{an approximation,} \\
& \text{a measurement bridge,} \\
& \text{or another auxiliary physical assumption.}
\end{aligned} \tag{962}$$

Therefore:

$$\text{ObservableModelSeparation} \not\Rightarrow \text{FoundationalAttributionIdentified} . \tag{963}$$

The attribution problem is a distinct stage of theory testing.

49.10 Open Problem 9: Empirical Access to Global Stages

V38/F18 contains two distinct empirical burdens. CMA requires an independently warranted bridge bearing on objective common-stage co-presence. UCC can be challenged by positive physical warrant that some qualified realized physical system is completely physically non-changing at an admitted member:

$$\exists A \in \mathcal{S}_{\text{phys}}(s) \text{ NC}_A^{\text{phys}}(s). \tag{964}$$

Because CMA and UCC are independent commitments, such a warranted counterinstance refutes UCC only; it does not by itself refute CMA. CMA requires an independently warranted challenge to objective common-stage co-presence. Since $\text{CosmicCoPresence}_C$ is a primitive meaning-fixed ontological relation, a formal countermodel may deny it while preserving the same formal cosmic-stage domain and incidence facts; whether such a denial is empirically accessible is a separate question. Coordinate disagreement, clock-rate differences, signal delay, frame-dependent synchronization, or finite observational silence do not by themselves challenge either burden.

49.11 Open Problem X: Class-Specific Identity

Empirical tests of CMA, AFB, UEIE, persistence, ending, and population transformation require domain-specific physical-system and numerical-identity criteria. Future work must construct physically warranted class-specific profiles

$$\mathfrak{Q}_{\mathcal{K}}^{\text{id}} = (\kappa_{\text{sys}}, \kappa_{\text{boundary}}, \kappa_{\text{id}}, \kappa_{\text{persist}}, \kappa_{\text{form}}, \kappa_{\text{end}})_{\mathcal{K}} \tag{965}$$

that distinguish continued numerical identity, functional alteration, component replacement, formation of a new identity, ending of an old identity, and successor production. For a given protocol these criteria must satisfy the prospective admissibility discipline of Eq. (198); V38/F18 does not supply one universal empirical identity criterion for all physical-system classes.

49.12 Eleventh open problem: complete cosmological extent

Equation (14) defines a possible non-terminating cosmological extension condition, but V38/F18 does not assert that the actual universe satisfies it. The scientific problem is first to determine what physically warranted evidence or cosmological theory could bear on whether realized physical change has a greatest future stage at all. Only if a specific non-termination hypothesis is adopted does the further question arise of whether a complete physical bridge can connect that hypothesis to discriminating observables or predictions.

A genuine empirical discriminator requires a complete physical-to-observable specification $\mathfrak{P}$ such that

$$P_{\text{ITOF}}(\mathcal{O} \mid \mathfrak{P}) \neq P_{\text{alt}}(\mathcal{O} \mid \mathfrak{P}). \quad (966)$$

If the complete physical specification is identical and yields the same observable distribution, the ontological difference alone does not generate a test:

$$P_{\text{ITOF}}(\mathcal{O} \mid \mathfrak{P}) = P_{\text{alt}}(\mathcal{O} \mid \mathfrak{P}) \implies \neg \text{PredictionSeparation}_{\mathfrak{P}}. \quad (967)$$

No temporal definition, stage symbol, CMA, or UCC supplies the required physical coupling or observable map by itself. Likewise,

$$\text{NonDetectionOfChange} \not\Rightarrow \text{CessationOfPhysicalChange}. \quad (968)$$

A finite observational gap, insensitive observable, threshold limitation, or unmeasured degree of freedom cannot be promoted into proof that the cosmic succession has stopped.

49.13 Research-program restraint

The open program is governed by:

$$\text{OpenProblem} \not\Rightarrow \text{CurrentITOFFailure}. \quad (969)$$

But also:

$$\text{OpenProblem} \not\Rightarrow \text{AlreadySolvedByFoundationalDefinition}. \quad (970)$$

Unresolved physical questions remain unresolved.

They must not be filled by semantic assertion.

50. Conclusion: Invariant Cosmic Extension, Co-Presence, and Change Continuity

V38/F18 defines time as the invariant universal cosmic extension and the objective, non-reversed succession of the common cosmic stages at which physical change is realized. Formally,

$$T_{\text{ITOF}} = (\mathcal{S}_{\text{C}}^{\text{tot}}, <_{\text{C}}). \quad (971)$$

The members of $\mathcal{S}_{\text{C}}^{\text{tot}}$ are formal stage expressions of realized physical change within that one objective earlier-later cosmic succession. A stage symbol formally expresses a realized physical

change in its ordered relation to other realized changes; it does not denote an additional ordering-position entity and is not a receptacle, physical state, change packet, clock reading, metric interval, coordinate, or causal agent. Thus

$$s \in \mathcal{S}_C^{\text{tot}} \implies \left[\text{RealizedChangeStage}_C(s) \iff \exists A \left[\text{PhysicalSystem}(A) \wedge \text{ExistsAs}(A, s) \right. \right. \\ \left. \left. \wedge \text{PhysReal}_A^+(s) \right] \right]. \quad (972)$$

This gives stage membership physical non-nullness without making the temporal ordered pair a dynamical law or asserting that change causes time.

The relation $\prec_C$ is designated as the objective earlier-later relation before Strict Cosmic Ordering imposes its strict-total-order properties. Non-reversal of the governing cosmic succession means that a later realization remains later even if its state is equal or equivalent to an earlier state:

$$r \prec_C t \wedge X_A(r) = X_A(t) \implies r \neq t \wedge \neg(t \prec_C r). \quad (973)$$

A physical trajectory may reverse a variable, recur, cycle, or reconstruct a previously realized state description; such a process is a new later dynamical change, not return to the earlier stage.

The formal cosmic-stage domain architecture supplies one cosmic-stage domain, while CMA independently states objective common-stage co-presence:

$$\text{CMA} \iff \forall s \in \mathcal{S}_C^{\text{tot}} : \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s). \quad (974)$$

The $\text{CosmicCoPresence}_C$ relation is not a synchronization signal, private-time identification map, coordinate equality, hidden interaction, or causal mechanism. UCC separately requires the distinct system-specific changes realized by qualified physical systems at their admitted identity-range members.

UCC isolates actual physical change without an admitted change-null member, in the non-metric sense, for every qualified physical system throughout the stages at which that identity is realized:

$$\text{UCC} \iff \forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A : \text{PhysReal}_A^+(s). \quad (975)$$

A terminal identity stage ends that identity's range; it does not erase the change already realized, and it does not terminate UCC for other persistent or newly formed qualified identities. Simple and composite systems are both admissible. Composite identity requires physically warranted interconnection and coherence at the declared organizational level, and constituent failure is not by itself composite identity ending.

The complete extent of cosmic change remains open. V38/F18 therefore does not include non-termination in temporal admissibility. It retains

$$\text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \iff \forall s \in \mathcal{S}_C^{\text{tot}} \exists t \in \mathcal{S}_C^{\text{tot}} (s \prec_C t) \quad (976)$$

only as an explicitly additional cosmological condition. If adopted together with temporal admissibility, it yields an infinite stage domain; with additional lifecycle premises it may also yield further conditional infinite-cardinality results. The symbol ∞ in such results is therefore conditional mathematical notation, not a constituent of the temporal definition and not a claim that present cosmological evidence has established an unlimited future.

The physical universe denotes $\mathfrak{U}_C^{\text{phys}}$, not an independent container surrounding physical entities and not a single numerical system identity. Its physical content consists of the governing totality of physical-system identities together with objectively realized physical factors. Consequently $\mathfrak{U}_C^{\text{phys}} \notin \mathcal{U}_{\text{phys}}$, and adoption of optional UEIE does not convert the cosmic physical totality into one universally ending system.

Physical-system realization and ontic systemhood are objective. A scientifically warranted class/granularity scheme $\mathfrak{Q}$ governs application-level identification, tracking, and attribution for particular systems without creating $\mathcal{U}_{\text{phys}}$ or the cosmic stages. This prevents arbitrary decomposition while allowing a subsystem and a coherent composite to be distinguished under physically warranted criteria at different organizational levels.

External physical influence preserves the same type discipline. A contributing physical system remains a system and is typed as an influencing physical-system source; influencing physical factors remain a separate class. “Response” denotes an application-level characterization of the magnitude, amount or extent, type, direction, or result of the realized physical change attributable to the influence; it is not a separate causal layer. The realized effect is system-specific and is conditioned by the system’s state, physically relevant coupling or susceptibility, and internal structural, dynamical, or organizational coherence. A supportive or adverse effect is therefore criterion-relative rather than an intrinsic sign carried by the contributor or by physical change itself.

CRP remains independent because physical-change actuality does not specify its causal contributors. AFB, Identity-Realization Convexity, PIECP, optional UEIE, and conditional successor attribution remain identity and lifecycle commitments. AFB constrains the least member of each realized identity range within the common cosmic-stage domain; it does not introduce a private stage or a beginning of physical change. Successor status requires genuine new-identity production; no universal postulate requires such production at every actual ending.

The quantitative program preserves the Non-Transfer Principle. Clock systems, observers, apparatus, record-bearing systems, and laboratory/reference systems remain physical systems where the governing criteria are satisfied and therefore remain within UCC rather than outside the changing physical domain. Their readings and records arise through physical processes. Clock readings, proper-time functionals, coordinate quantities, and metric intervals do not become the ITOF temporal referent through successful application. Conversely, time, CMA, UCC, or the optional non-termination condition do not manufacture Hamiltonians, couplings, measurement maps, or observable residuals. Under identical complete physical-to-observable specifications, ontological difference alone does not create prediction separation.

The governing V38/F18 core is therefore

$$\begin{aligned}
T_{\text{ITOF}} &= (\mathcal{S}_C^{\text{tot}}, \prec_C), \\
\text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) &\iff [\mathcal{S}_C^{\text{tot}} \neq \emptyset] \wedge \text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) \\
&\quad \wedge \forall s \in \mathcal{S}_C^{\text{tot}} \text{ RealizedChangeStage}_C(s) \\
&\quad \wedge \exists r \in \mathcal{S}_C^{\text{tot}} \exists t \in \mathcal{S}_C^{\text{tot}} (r \prec_C t), \\
\text{CSPP} &\iff \forall s \in \mathcal{S}_C^{\text{tot}} : \mathcal{S}_{\text{phys}}(s) \neq \emptyset \quad (\text{derived}), \\
\text{CMA} &\iff \forall s \in \mathcal{S}_C^{\text{tot}} : \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s), \\
\text{UCC} &\iff \forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A : \text{PhysReal}_A^+(s).
\end{aligned} \tag{977}$$

The architecture keeps its roles separate. An admitted stage has non-null semantic content because it formally expresses objectively realized physical change; scientific attribution of a particular realization remains subject to independent physical warrant. Strict ordering and the nontrivial earlier–later pair provide order structure and non-degeneracy. The formal cosmic-stage domain architecture supplies one cosmic-stage domain. CMA independently supplies objective common-stage co-presence. UCC independently supplies system-specific physical-change continuity throughout every realized identity range. Independently sourced physics supplies dynamics, causal attribution, and empirical bridges.

51. Statement-Status and Dependency Register

Table 1: Logical status and direct role of principal V38/F18 statements and constructions.

Item	Status	Direct dependency or role
$\mathcal{S}_C^{\text{tot}}$	Primitive formal cosmic-stage domain	Formal cosmic-stage domain whose admitted members are formal stage expressions of realized physical change in the one universal cosmic succession. A written stage symbol designates a member of the formal cosmic-stage domain; neither the symbol nor the member is a further physical or ontic stage object behind the realized change it expresses.

Item	Status	Direct dependency or role
One-global-stage domain architecture	Foundational formal architecture	Explicates the single-domain content fixed by the governing temporal definitions, with every I_A a restriction of that same formal cosmic-stage domain. This is not derived from strict ordering, population notation, synchronization, clock agreement, or coordinate choice. Private per-system stage domains followed by mapping or synchronization instantiate a different temporal ontology.
$\prec_C$	Primitive ordering relation with governing semantic designation	The one objective earlier–later relation on $\mathcal{S}_C^{\text{tot}}$. Its earlier–later orientation is designated by ITOF semantics; Strict Cosmic Ordering constrains that designated relation rather than selecting it over its inverse.
Strict Cosmic Ordering	Foundational axiom	Requires $\prec_C$ to be a strict total order on $\mathcal{S}_C^{\text{tot}}$; yields asymmetry and total comparability but does not itself supply the semantic orientation.
NonTerminating CosmicSuccession _C	Optional cosmological condition	Requires every admitted stage to have a later stage. It is non-metric and order-theoretic, but V38/F18 does not assume that the complete future satisfies it; all results using it are conditional.
Temporal-extension admissibility	Defined temporal-admissibility condition	Requires a nonempty formal cosmic-stage domain, Strict Cosmic Ordering, actual realized-change stage meaning for every admitted member, and at least one nontrivial earlier–later pair. The last requirement excludes a succession-free singleton but neither asserts nor denies a greatest future stage. Temporal admissibility neither entails CMA nor entails UCC.
Order-representation non-metricity	Derived mathematical result	Any supplied order representation remains non-unique under strictly increasing reparameterization; the ordering alone does not determine a canonical scalar interval magnitude.

Item	Status	Direct dependency or role
T_{ITOF}	Governing definition	$T_{\text{ITOF}} := \mathcal{E}_C := (\mathcal{S}_C^{\text{tot}}, <_C)$. Time denotes the one universal earlier–later extension of objectively realized physical change. A written stage symbol designates a member of the formal cosmic-stage domain; that member expresses realized change in the order without becoming a temporal container, physical stage object, or causal agent. Unlimited future extent is not built into the definition.
CosmicOrigin	Optional independent cosmological postulate	Optional commitment that $\mathcal{S}_C^{\text{tot}}$ possesses one unique least member. Non-termination toward later stages does not entail an origin.
$\mathcal{U}_C^{\text{phys}}$	Defined cosmic physical totality	Physical universe understood as the typed totality of physical-system identities and physically realized physical factors. It is neither an independent physical container nor a numerical physical-system identity.
$\mathfrak{F}_{\text{phys}}$	Defined physical-factor totality	Physically realized physical-factor reality that is type-distinct from a numerical physical-system identity; every admitted factor has stage support by Eq. (48), while actual influence on a particular system is not required for membership.
FactorRealizedAt(F, s)	Typed stage-relative factor-realization relation	Records physical realization of factor F at admitted stage s ; it does not by itself assert causal influence on a system.
$\mathfrak{F}_{\text{phys}}(s)$	Defined stage-relative physical-factor population	Physical factors realized at admitted stage s ; membership alone does not assert influence on a system.
$\mathcal{U}_C^{\text{phys}}(s)$	Defined stage-relative cosmic physical totality	Typed stage-relative totality $\mathcal{S}_{\text{phys}}(s) \sqcup_{\text{ont}} \mathfrak{F}_{\text{phys}}(s)$; neither a container nor a retyping of factors as systems.

Item	Status	Direct dependency or role
$\mathfrak{F}_{\text{phys}}^{\text{inf}}$	Defined influencing physical-factor domain	Members of $\mathfrak{F}_{\text{phys}}$ that actually influence at least one realized system–stage pair; scientific attribution of a particular influence requires applicable physical warrant.
$\mathcal{U}_{\text{phys}}$	Defined physical-system totality	Objectively realized numerical physical-system identities possessing at least one realized identity member in $\mathcal{S}_{\text{C}}^{\text{tot}}$. Class/granularity schemes govern application-level identification and attribution rather than ontic systemhood.
I_A	Defined identity-realization range	Subset of the one cosmic-stage domain at which numerical identity A is realized; it is an identity-bounded restriction, not a private time.
$\mathcal{S}_{\text{phys}}(s)$	Defined population	Complete qualified physical-system population realized at s , obtained from memberwise identity-stage incidence.
$\text{CosmicCoPresence}_{\text{C}}(P; s)$	Primitive meaning-fixed ontological relation	Expresses objective co-realization of the members of P at one and the same cosmic stage s . It is not definitionally reducible to population membership, synchronization, signal access, interaction, or coordinate equality.
CSPP	Derived population principle	Records the consequence $\mathcal{S}_{\text{phys}}(s) \neq \emptyset$ for every admitted $s \in \mathcal{S}_{\text{C}}^{\text{tot}}$, because each admitted stage is a formal expression of objectively realized physical change and therefore has a nonempty qualified change-realizing population. It is not an additional independent postulate.
CMA	Independent governing foundational axiom	Requires objective common-stage co-presence of the complete then-realized qualified population. It does not assert complete all-system change; that independent physical burden belongs to UCC.

Item	Status	Direct dependency or role
UCC	Independent foundational physical postulate	Requires system-specific physical change to continue without an admitted change-null member throughout every qualified physical system's realized identity range. Equivalently, for every admitted member $s \in \mathcal{S}_C^{\text{tot}}$, every qualified system whose identity range contains s realizes actual physical change. UCC is not the cosmic non-termination condition and supplies no universal scalar rate or magnitude.
CommonChange $\text{StageRole}_C(s)$	Defined full-theory stage role	Stage-relative role requiring an admitted realized-change stage, CMA common-stage co-presence, and UCC complete qualified-system actual-change coverage. Minimal physical non-nullness is already supplied by stage semantics.
Complete physical non-change	Defined qualitative contrary predicate	Equivalent to $\neg \text{PhysReal}_A^+(s)$ for $s \in I_A$. Application of this contrary requires positive physical warrant under the applicable theory/model and declared system boundary and granularity that no physically constitutive change admissible to the claim is realized at that pair. Selected-observable equality or finite non-detection is insufficient. A warranted instance is the direct change countercondition to UCC; it is not by itself a countercondition to CMA.
I_A^Δ	Defined actual-change subset	Members of I_A at which actual physical change is realized; equals I_A under UCC.
Δ_A^{phys}	Typed physical-change map	$\Delta_A^{\text{phys}} : I_A^\Delta \rightarrow \Xi_A$; preserves system-specific change content and countermodel typing.
$\mathcal{B}_\Delta(s)$	Defined population subset	Change-realizing members of $\mathcal{S}_{\text{phys}}(s)$; equality with the entire population at every s is equivalent to UCC.

Item	Status	Direct dependency or role
$\text{GlobalChangeNull}_C(s)$	Defined stage-relative null predicate	Holds exactly when $\mathcal{B}_\Delta(s) = \emptyset$. Governing stage admissibility already excludes it at every admitted stage; UCC strengthens the result to change realization by every then-realized qualified physical system. It does not denote a universal numerical zero.
$\mathfrak{D}_C(s)$	Defined construction	Dependent system-indexed physical-change-content profile.
$\text{StageChangeBridge}_C(s)$	Defined foundational representation	Defined local conjunction of CMA common-stage co-presence and UCC complete-population physical-change realization. The representation is not an axiom, cause, synchronization rule, or observation bridge.
$X_A : I_A \rightarrow \Omega_A$	Defined physical-state map	System-specific physical state realized at each member of I_A .
$\mathfrak{X}_C(s)$	Defined construction	Dependent complete-population profile of system-specific physical states.
CRP	Independent foundational physical postulate	Requires nonempty actual physical causal realization for every actual system-specific physical change.
$\mathfrak{G}_C(s)$	Defined construction	Complete-population mapping from each realized system to its actual causal set.
$\mathfrak{R}_C(s)$	Defined construction	Integrates population, state profile, change profile, and causal-realization profile without becoming a temporal object.
$\mathfrak{R}_C^{[M]}(s)$	Application-level defined augmentation	Adds independently warranted model-relative physical relations to the complete-population realization profile without changing temporal identity or claiming exhaustive physical description.

Item	Status	Direct dependency or role
CMA–UCC–CRP stage-relative realization consequence	Derived consequence	Under temporal admissibility together with CMA, UCC, and CRP, every admitted stage is nonempty, satisfies the local Stage-to-Change condition, and has nonempty actual causal realization for every qualified member; no additional realization predicate is introduced.
$A \triangleleft_{\kappa,s} B$	Defined current-version physical relation	Stage-relative constituent/subsystem relation under declared physical composition criterion κ ; does not itself provide cross-level dynamics.
$\mathfrak{K}_C(s)$	Defined construction	Collection of warranted stage-relative constituent relations among qualified physical-system identities.
Cross-Level Non-Transfer	V38 physical/type principle	Composition alone does not transfer state, physical-change content, causal determination, or numerical identity across system levels.
Identity-Realization Convexity	Independent foundational identity postulate	Prevents an internal gap in one numerical identity range.
AFB	Independent identity postulate	Requires one unique least member for every qualified identity range within the single common cosmic-stage domain; does not introduce a private stage or a change-onset claim.
$\mathfrak{Q}_{\mathcal{K}}^{\text{id}}$	V38/F18 class-indexed application- admissibility formalization	Six-component current profile governing system class, boundary, numerical identity, persistence, formation, and ending criteria where relevant; not a universal identity criterion and not a temporal component.
$\mathcal{H}_A$	Formal history representation	$(I_A, \prec_C \upharpoonright_{I_A}, X_A, \Delta_A^{\text{phys}})$; not a private time.
Historical Physical Accumulation	Historical designation	Earlier actually realized system-specific physical change; not an arithmetic sum or causal-source class.

Item	Status	Direct dependency or role
Present Cumulative Physical Resultant	Defined present-resultant predicate	States that retained or transformed earlier effects remain physically embodied in the present developed condition.
$\text{End}_A(e)$	Defined identity-ending predicate	Physical identity-ending transformation at the final member of numerical identity A .
PIECP	Independent ending-specific causal postulate	Requires at least one actual causal contributor to contribute specifically to the identity-ending transformation.
UEIE	Optional universal lifecycle postulate	Requires eventual identity ending together with nonempty strict pre-ending identity history. Its quantifier ranges over the governing ontic physical-system totality $\mathcal{U}_{\text{phys}}$. Empirical attribution of ending within any declared class still requires an independently warranted class-specific numerical-identity criterion; no universal empirical identity criterion is supplied.
$\text{SuccAt}(A, B; e)$	Defined direct-successor relation	New numerical identity B is physically produced through the ending transformation of A at e .
$\mathfrak{S}^+(A, e)$	Defined successor family	Direct successors physically produced through the ending of A at e ; the set may be empty when the ending produces no new qualified identity.
$\mathcal{P}_{r,s}$	Defined current-version set	Systems whose numerical identities are realized at both ordered endpoints.
$\mathcal{N}_{r \rightarrow s}$	Defined current-version set	Systems absent at r and realized at s .
$\mathcal{L}_{r \rightarrow s}$	Defined current-version set	Systems realized at r and absent at s .
$\mathcal{T}_{r,s}$	Defined current-version set	Identities realized strictly between r and s while absent from both selected endpoints.
Cross-system comparison maps	Application-level defined constructions	Map system-specific physical quantities into a declared common comparison space without identifying the underlying physical quantities.

Item	Status	Direct dependency or role
Mathematical-form-neutral dynamics	Application architecture	Uses a typed internal dynamics descriptor and separates physical encoding, dynamics, model-to-prediction mapping, and measurement. It permits independently warranted deterministic, stochastic, quantum, field, geometrical, or other model classes without defining one universal dynamics.
$\mathfrak{A}_{A,\alpha}$	Current application-level construction	Criterion-indexed physical directionality for a declared system and physical model; may align with the cosmic order without becoming that order or a second time.
$\mathcal{M}_P^{\text{op}}$	Current application-level construction	Maps physical records and calibration conditions to an operational metric quantity; output remains type-distinct from time.
Exact-Change-Stage Restraint	Epistemic principle	Observation may warrant manifestation at some actual common cosmic change stage without automatically identifying the exact stage or global order position. The source, apparatus, record-bearing systems, observer, and laboratory/reference systems remain within the changing physical domain; UCC contributes this physical non-stasis but does not alone prove non-invertibility of an observation map.
Foundational empirical bridge	V38 methodological bridge architecture	Records the independently specified physical, observational, auxiliary, uncertainty, and attribution conditions connecting a foundational commitment to an observable and to any subsequent foundation-sensitive inference.
Foundational Empirical Attribution Principle	Methodological inferential principle	Restricts foundational inference to cases with independent bridges, frozen protocol, identifiable prediction separation, valid uncertainty, and controlled alternative attribution.

Item	Status	Direct dependency or role
$\mathfrak{Q}_{\text{MD}}$	Application-level quantitative physical-model branch	Independently sourced mass-defect and trapped-ion clock-response program used for benchmark recovery and forward physical modeling; not a temporal component and not by itself a foundation-specific prediction.
Same physical specification	Defined application-comparison predicate	Holds exactly when the complete physically operative target-to-observable specifications $\mathfrak{S}_I^{P,D}$ and $\mathfrak{S}_R^{P,D}$ are equal; temporal ontological interpretation is not a component of that tuple.
Physical-Prediction Non-Separation under Identical Physical-to-Observable Specification	Derived dependency/identifiability proposition	From equality of the complete physical-to-observable specifications, identical prediction rules and observable maps yield identical predicted observables. The result is a dependency boundary, not a new dynamical law.
NTP	Foundational type principle	Mathematical consistency, physical applicability, and predictive or operational success do not by themselves transfer temporal identity.
$\mathcal{Q}_{\text{rel}}$	External model family	Relativistic coordinate, metric, proper-time, simultaneity, foliation, cosmological, and related quantities tested for temporal nonidentity.
$\mathfrak{B}_{I:R}^{P,D}$	Current empirical-comparison architecture	Connects independently specified ITOF and relativistic application branches to one observable comparison domain without temporal-identity merger.
$\delta_{I:R}^{P,D}$	Current methodological comparison quantity	Infimum prediction separation across independently admissible ITOF and relativistic bridge classes; used to test whether separation survives residual bridge freedom.

52. Governing Symbol and Type Register

Table 2: Core V38/F18 notation and governing meanings.

Symbol	Type	Meaning
T_{ITOF}	Temporal referent	Time in ITOF V38/F18.
$\mathcal{E}_C$	Temporal referent	The same one universal non-metric cosmic extension denoted by T_{ITOF} .
$\mathcal{S}_C^{\text{tot}}$	Formal cosmic-stage domain	Formal cosmic-stage domain of formal stage expressions of realized physical change in the one universal cosmic succession. Membership supplies minimal actual-change realization but does not analytically entail CMA or the complete qualified-system coverage of UCC.
$\prec_C$	Strict order	Designated governing objective earlier–later relation; strict-order properties are imposed separately.
ι	Order-representation map	Optional injective representation of the cosmic order in a declared ordered label domain; its labels and numerical intervals are not time.
$\text{NonTerminatingCosmicSuccession}_C$	Conditional cosmological condition	If adopted for a cosmological model, every admitted cosmic stage has a later stage; formally this is absence of a greatest member. V38/F18 does not assume that the complete future satisfies this condition.
s_C^0	Boundary symbol	Unique least cosmic stage where Cosmic Origin is separately adopted.
$\mathfrak{U}_C^{\text{phys}}$	Cosmic physical totality	Physical universe as the typed ontological totality of physical-system identities and physically realized physical factors; not a physical container and not one numerical physical-system identity.
$\mathfrak{F}_{\text{phys}}$	Physical-factor totality	Physically realized physical-factor reality, type-distinct from numerical physical-system identity; every admitted factor has stage support in $\mathcal{S}_C^{\text{tot}}$, while actual influence on a particular system is represented separately.
$\text{FactorRealizedAt}(F, s)$	Stage-relative factor realization	Records physical realization of non-system factor F at s , separately from any warranted causal-influence relation.

Symbol	Type	Meaning
$\mathfrak{F}_{\text{phys}}(s)$	Stage-relative physical-factor population	Physical factors realized at admitted stage s , irrespective of whether they influence a particular system.
$\mathfrak{U}_{\text{C}}^{\text{phys}}(s)$	Stage-relative cosmic physical totality	Typed union of the physical-system population and physical-factor population realized at s ; not a container or a physical-system identity.
$\mathfrak{F}_{\text{phys}}^{\text{inf}}$	Influencing physical-factor domain	Those members of the physical-factor totality that actually influence at least one realized system–stage pair; attribution of a particular influence requires applicable physical warrant.
$\mathcal{U}_{\text{phys}}$	Physical-system totality	Governing totality of objectively realized physical-system identities having at least one realized member in $\mathcal{S}_{\text{C}}^{\text{tot}}$. Application schemes $\mathfrak{Q}$ select warranted subdomains for identification, tracking, or testing but do not create this totality.
I_A	Identity range	Members of $\mathcal{S}_{\text{C}}^{\text{tot}}$ at which numerical identity A is physically realized.
I_A^{Δ}	Actual-change subset	Members of I_A at which actual system-specific physical change is realized.
$\mathcal{S}_{\text{phys}}(s)$	Population	Complete qualified physical-system population realized at s .
CSPP	Derived-principle symbol	Cosmic Change-Stage Population Principle; a consequence of the revised realized-change stage semantics, retained as a useful named population result.
CMA	Axiom symbol	Cosmic Moment Axiom.
UCC	Foundational postulate symbol	Universal Change Continuity; the independent system-specific physical-change postulate requiring actual physical change throughout every realized identity range.

Symbol	Type	Meaning
CommonChange StageRole _C (s)	Defined stage-role predicate	Full-theory role-name for an admitted realized-change stage within the constitutive one-global-stage architecture, with CMA objective common-stage co-presence and UCC complete system-specific actual-change coverage. Stage membership already supplies minimal physical-change actuality but not the stronger complete-population change role.
PhysReal _A ⁺ (s)	Physical relation	Actual system-specific physical change realized by A at s . Attribution requires independent physical warrant under the applicable theory/model and a declared system boundary and granularity; stage membership or detection alone does not supply that warrant.
Ξ_A	Change-content type	System-specific codomain for physical-change content.
$\Delta_A^{\text{phys}}(s)$	Physical-change content	System-specific physical content of change for an actual-change pair.
$\mathcal{B}_\Delta(s)$	Population subset	Change-realizing members of the stage-relative population.
$\mathfrak{D}_C(s)$	Dependent profile	System-indexed family of physical-change contents.
StageChangeBridge _C (s)	Defined foundational bridge	Defined local conjunction of CMA common-stage co-presence and UCC complete-population actual-change coverage.
Ω_A	Physical state space	Declared state space appropriate to system A .
$X_A(s)$	Physical state	State of system A realized at s .
$\mathfrak{X}_C(s)$	V38 state profile	Complete-population dependent family of system-specific physical states.
$\mathfrak{C}_A(s)$	Causal profile	Internal physical contributors and external physical-influence sources. The external set contains influencing physical systems and influencing physical factors; each source retains its physical type.

Symbol	Type	Meaning
$\mathcal{E}_A^{\text{ext}}(s)$	Defined external-influence set	External physical-influence sources applicable to physical system A at s , formed by the union of influencing physical systems and influencing physical factors.
System-specific external response	Application-level characterization	Characterizes, where physically warranted, the magnitude, amount or extent, type, direction, or result of physical change actually realized under a declared external-influence attribution. It is prose-level application terminology, not an intermediate causal layer, universal response variable, causal-source class, or temporal law.
Criterion-relative external impact	Application-level classification	Supportive/beneficial, adverse/harmful, mixed, or neutral impact is assigned only relative to a declared physical or functional criterion; unresolved is an epistemic status rather than an additional physical impact type.
$\mathcal{C}_A^{\text{act}}(s)$	Actual causal set	Union of the actual physical causal contributors for the change of A at s .
$\mathfrak{G}_C(s)$	V38 causal profile	Population-indexed family of actual causal sets.
$\mathfrak{R}_C(s)$	V38 realization profile	Population, physical-state, physical-change, and causal-realization architecture at common cosmic change stage s .
$\mathfrak{R}_C^{[M]}(s)$	Relational augmentation	Model-relative enrichment of the complete-population realization profile by additional independently warranted physical relations.
$A \triangleleft_{\kappa,s} B$	Composition relation	Qualified physical-system identity A is physically realized as a proper constituent or subsystem of B under criterion κ at s .
$\mathfrak{R}_C(s)$	Composition profile	Collection of warranted stage-relative constituent relations.
f_A	Formation boundary	Unique least member of I_A under AFB within the common cosmic-stage domain; not a private stage or a marker for the beginning of physical change.

Symbol	Type	Meaning
e_A	Ending boundary	Identity-ending member where an ending exists.
$\mathcal{H}_A$	History representation	Identity domain, restricted common order, state map, and physical-change-content map.
$\mathcal{P}_{r,s}$	Population set	Identities realized at both r and s .
$\mathcal{N}_{r \rightarrow s}$	Population set	Identities absent at r and realized at s .
$\mathcal{L}_{r \rightarrow s}$	Population set	Identities realized at r and absent at s .
$\mathcal{T}_{r,s}$	Population set	Identities realized only at one or more members strictly between selected endpoints r and s .
$\text{Cmp}_{AB,P}(s)$	Comparison output	Mapped comparison of declared system-specific physical-change quantities.
$\mathfrak{A}_{A,\alpha}$	Physical-directionality descriptor	Criterion-indexed triple $(\mathcal{Y}_{A,\alpha}, Y_{A,\alpha}, \preceq_{A,\alpha})$ used to represent a physically warranted directional regularity over I_A .
$\text{ArrowAligned}_{A,\alpha}(J)$	Directionality predicate	The selected physical descriptor is nondecreasing according to its declared criterion relation over $J \subseteq I_A$; not a second temporal ordering.
λ_M	Model parameter	Declared evolution or representation parameter of application model M ; not automatically time.
$\mathcal{M}_P^{\text{op}}$	Operational map	Maps records and calibration structures to an operational metric quantity.
r	Physical record	Physically produced record in an acquisition chain.
J_r^{phys}	Physical support set	Common cosmic change stages whose physical realizations contribute to production of record r .
$\mathfrak{P}^*$	Test protocol	Predeclared quantitative test architecture.
$\mathfrak{B}_F^{P,D}$	Empirical bridge tuple	Physical, observational, auxiliary, uncertainty, and attribution conditions connecting foundational commitment F to empirical evaluation.
NTP	Type principle	Generalized Non-Transfer Principle.

Symbol	Type	Meaning
$\mathcal{Q}_{\text{rel}}$	External quantity family	Declared relativistic quantities and representations examined for temporal nonidentity.
$\mathfrak{B}_{I:R}^{P,D}$	Comparison bridge	ITOF-relativistic observable comparison architecture.
$\delta_{I:R}^{P,D}$	Robust separation margin	Infimum common-observable prediction separation over independently admissible bridge classes for the two comparison branches.

53. Formal Models and Dependencies

53.1 Logical status of formal model constructions

Formal model constructions test satisfiability, definitional conservativity, and declared logical dependencies; they are not empirical cosmological models or microscopic dynamics. For commitments Γ and proposition P ,

$$\text{Model}[\Gamma \wedge \neg P] \implies \Gamma \not\models P. \quad (978)$$

Conversely,

$$\text{FormalModelExists}(M) \not\Rightarrow \text{PhysicallyRealized}(M). \quad (979)$$

53.2 Typed realization-core signature

Use the primitive typed language

$$\begin{aligned} \Sigma_{38}^{\text{primitive}} &:= \langle \mathcal{S}_C, \mathcal{U}_{\text{phys}}; \prec_C, \text{ExistsAs}, \text{PhysReal}^+, \text{CosmicCoPresence}_C \rangle, \\ \prec_C &\subseteq \mathcal{S}_C \times \mathcal{S}_C, \quad \text{ExistsAs} \subseteq \mathcal{U}_{\text{phys}} \times \mathcal{S}_C, \\ \text{PhysReal}^+ &\subseteq \mathcal{U}_{\text{phys}} \times \mathcal{S}_C, \quad \text{CosmicCoPresence}_C \subseteq \mathcal{P}(\mathcal{U}_{\text{phys}}) \times \mathcal{S}_C. \end{aligned} \quad (980)$$

The objects I_A , I_A^Δ , $\mathcal{S}_{\text{phys}}(s)$, $\mathcal{B}_\Delta(s)$, and $\text{RealizedChangeStage}_C(s)$ are defined constructions. The relation $\text{CosmicCoPresence}_C(P; s)$ is instead primitive and meaning-fixed: identity-stage incidence determines which qualified identities are represented at s , but does not by itself establish their objective collective co-presence. CMA independently requires that co-presence for the complete stage population. UCC independently requires complete physical-change actuality in every qualified physical system throughout its realized identity range.

53.3 Domain admissibility

$$\text{DomainAdmissible}_{38} \iff \forall A \in \mathcal{U}_{\text{phys}} \exists s \in \mathcal{S}_C^{\text{tot}} \text{ExistsAs}(A, s). \quad (981)$$

This enforces the definition of $\mathcal{U}_{\text{phys}}$ and is not an additional physical postulate.

53.4 Governing realization-core model

A governing V38/F18 realization-core model satisfies

$$\mathfrak{M} \models \mathfrak{G}_{38}^{\text{core}} \iff \text{DomainAdmissible}_{38} \wedge \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \wedge \text{CMA} \wedge \text{UCC}. \quad (982)$$

CSPP follows from temporal stage admissibility and is therefore not an independent core conjunct. UCC is an independent physical postulate and is therefore included explicitly alongside CMA in the governing realization core. The typed realization-core signature intentionally omits the separate physical-factor module; any fuller model that instantiates members of $\mathfrak{F}_{\text{phys}}$ must also satisfy the stage-support requirement in Eq. (48). This does not add physical factors to CMA or UCC quantification. Non-terminating cosmic succession is absent from the governing core: it may be added as a conditional cosmological premise in a stronger model. CRP, identity, lifecycle, observation, composition, and application modules retain their separate statuses.

Proposition 53.1 (Governing-core expansion). Under Eq. (19),

$$\begin{aligned} \mathfrak{M} \models \mathfrak{G}_{38}^{\text{core}} \iff & \text{DomainAdmissible}_{38} \wedge [\mathcal{S}_C^{\text{tot}} \neq \emptyset] \wedge \text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C) \\ & \wedge \forall s \in \mathcal{S}_C^{\text{tot}} \text{ RealizedChangeStage}_C(s) \\ & \wedge \exists r \in \mathcal{S}_C^{\text{tot}} \exists t \in \mathcal{S}_C^{\text{tot}} (r \prec_C t) \wedge \text{CMA} \wedge \text{UCC}. \end{aligned} \quad (983)$$

53.5 Historical status of realization-core elements

The V38/F18 realization core is governed by the present definitions and commitments. Earlier versions are relevant only as developmental history. Where a predecessor formulation expresses the same stated content, V38/F18 may describe that content as retained; where the earlier formulation is insufficient, the present version corrects, strengthens, or reclassifies it. No undefined cross-version equivalence predicate is used as a substitute for this item-specific assessment.

53.6 A joint-satisfiability witness

Let

$$\mathcal{S}_C^{\text{tot}} = \mathbb{N}_0, \quad m \prec_C n \iff m < n. \quad (984)$$

Then $\mathcal{S}_C^{\text{tot}} \neq \emptyset$ and Strict Cosmic Ordering holds. This particular witness also satisfies the stronger optional condition

$$\forall n \in \mathbb{N}_0 \exists m \in \mathbb{N}_0 (n < m), \quad (985)$$

so $\text{NonTerminatingCosmicSuccession}_C(\mathbb{N}_0, <)$ holds in the witness even though non-termination is not required by the governing core. If Cosmic Origin is separately adopted, $s_C^0 = 0$ satisfies it.

Let

$$\mathcal{U}_{\text{phys}} = \{A_0, A_1, A_2, \dots\}, \quad I_{A_k} = \{k, k+1\}. \quad (986)$$

Every range is convex with $f_{A_k} = k$ and $e_{A_k} = k+1$. Assign the relevant ending transformation so that $\text{End}_{A_k}(k+1)$ holds. At stage n ,

$$\mathcal{S}_{\text{phys}}(n) = \begin{cases} \{A_0\}, & n = 0, \\ \{A_{n-1}, A_n\}, & n \geq 1, \end{cases} \quad \mathcal{S}_{\text{phys}}(n) \neq \emptyset, \quad (987)$$

so CSPP holds. The assigned identity ranges fix the stage populations. Independently assign objective collective co-presence by

$$\forall n \in \mathbb{N}_0, \quad \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(n); n), \quad (988)$$

which satisfies CMA without deriving co-presence from incidence. Assign complete system-specific actual change by

$$\forall k \forall n \in I_{A_k}, \quad \text{PhysReal}_{A_k}^+(n). \quad (989)$$

This assignment satisfies CMA and UCC as separate conditions; both are jointly satisfiable with the temporal and population core, and

$$\forall n \in \mathbb{N}_0, \quad \mathcal{B}_\Delta(n) = \mathcal{S}_{\text{phys}}(n) \neq \emptyset. \quad (990)$$

This witness is a consistency construction, not a proposed physical cosmology.

For the causal and lifecycle extensions used below, choose for every realized pair (A_k, n) one explicitly internal physical contributor $c_{k,n}$:

$$\mathcal{C}_{A_k}^{\text{int}}(n) = \{c_{k,n}\}, \quad \mathcal{C}_{A_k}^{\text{infl-sys}}(n) = \emptyset, \quad \mathcal{C}_{A_k}^{\text{infl-factor}}(n) = \emptyset, \quad (991)$$

so that

$$\mathcal{C}_{A_k}^{\text{act}}(n) = \{c_{k,n}\}. \quad (992)$$

This supplies a fully typed witness for the causal-source union; it is only one consistency assignment and does not privilege internal causation in physical applications. Assign

$$\text{PhysicallyContributes}(c_{k,n}; \Delta_{A_k}^{\text{phys}}(n)). \quad (993)$$

CRP is therefore satisfied. At the ending member assign

$$\text{PhysicallyContributes}(c_{k,k+1}; \text{IdentityEndingTransformation}(A_k; k+1)), \quad (994)$$

so PIECP holds. The ranges $I_{A_k} = \{k, k+1\}$ are convex, have least member k , and contain the strict pre-ending member k before $e_{A_k} = k+1$; thus Identity-Realization Convexity, AFB, and the optional UEIE extension are simultaneously satisfiable in the same witness.

53.7 Independence of CMA from Identity–Stage Incidence and UCC

The distinction between one-identity-stage incidence and objective common-stage co-presence is model-theoretic, not merely terminological. Consider the finite structure

$$\mathcal{S}_C^{\text{tot}} = \{0, 1\}, \quad 0 \prec_C 1, \quad \mathcal{U}_{\text{phys}} = \{A, B\}, \quad I_A = I_B = \{0, 1\}. \quad (995)$$

Assign

$$\forall X \in \{A, B\} \forall s \in \{0, 1\}, \quad \text{PhysReal}_X^+(s), \quad (996)$$

so temporal stage admissibility, CSPP, and UCC are satisfied, with $\mathcal{S}_{\text{phys}}(0) = \mathcal{S}_{\text{phys}}(1) = \{A, B\}$. Interpret the primitive co-presence relation so that

$$\neg \text{CosmicCoPresence}_C(\{A, B\}; 0), \quad \text{CosmicCoPresence}_C(\{A, B\}; 1). \quad (997)$$

Then CMA is false although the common formal cosmic-stage domain, identity-stage incidence, realized-change stage semantics, CSPP, and UCC remain satisfied. Hence

$$\text{DomainAdmissible}_{38} \wedge \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \wedge \text{UCC} \not\Rightarrow \text{CMA}. \quad (998)$$

This countermodel does not assert that objective co-presence fails in the actual universe. It establishes only that CMA is an independent ontological commitment and is not a definitional consequence of membership in the formal cosmic-stage domain, incidence, or UCC.

53.8 Stagewise and Systemwise Forms of UCC

The conversion between the stagewise and systemwise forms of UCC uses the common stage domain and the stage-population definition

$$A \in \mathcal{S}_{\text{phys}}(s) \iff [A \in \mathcal{U}_{\text{phys}} \wedge s \in I_A]. \quad (999)$$

UCC's stagewise clause is

$$\forall s \in \mathcal{S}_C^{\text{tot}} \forall A \in \mathcal{S}_{\text{phys}}(s) : \text{PhysReal}_A^+(s), \quad (1000)$$

and re-indexing the same identity-stage pairs gives

$$\forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A : \text{PhysReal}_A^+(s), \quad (1001)$$

which is the systemwise form of UCC. This quantifier conversion concerns UCC only; it does not convert UCC into CMA. This re-indexing establishes only the equivalence of two formulations of UCC. CMA remains a separate common-stage co-presence axiom.

53.9 State and change profiles in the consistency witness

For each A_k , let:

$$\Omega_{A_k} = \mathbb{N}_0 \quad (1002)$$

and define:

$$X_{A_k}(n) = n + k. \quad (1003)$$

Let:

$$\Xi_{A_k} = \mathbb{N}_0 \times \{k\} \quad (1004)$$

This codomain keeps the change content explicitly system-typed in the consistency model.

Define the corresponding change-content map by

$$\Delta_{A_k}^{\text{phys}}(n) = (n, k). \quad (1005)$$

Then Eq. (990) supplies the complete change-realizing population at every n .

The state profile:

$$\mathfrak{X}_C(n) = (A_k \mapsto n + k)_{A_k \in \mathcal{S}_{\text{phys}}(n)} \quad (1006)$$

is well defined.

The change profile:

$$\mathfrak{D}_C(n) = (A_k \mapsto (n, k))_{A_k \in \mathcal{S}_{\text{phys}}(n)} \quad (1007)$$

is well defined.

The causal-realization profile:

$$\mathfrak{G}_C(n) = (A_k \mapsto \{c_{k,n}\})_{A_k \in \mathcal{S}_{\text{phys}}(n)} \quad (1008)$$

is well defined.

Hence:

$$\mathfrak{R}_C(n) = (\mathcal{S}_{\text{phys}}(n), \mathfrak{X}_C(n), \mathfrak{D}_C(n), \mathfrak{G}_C(n)) \quad (1009)$$

exists at every n .

Therefore the witness satisfies, at every n , the nonempty population, local stage-change, and nonempty causal-realization conditions of Eq. (169). No additional temporal object or realization predicate is introduced.

53.10 Optional successor links in the joint witness

The consistency witness does not require successor production. One admissible extension may nevertheless assign, for selected k ,

$$\text{PhysicalProductionLink}(A_k, A_{k+1}; k + 1) \quad (1010)$$

and therefore

$$\text{SuccAt}(A_k, A_{k+1}; k + 1). \quad (1011)$$

Because $f_{A_{k+1}} = k + 1$, such a $B = A_{k+1}$ is a genuinely new direct successor in that selected extension. The same base witness remains admissible without any such assignment, demonstrating that successor production is not a universal lifecycle requirement.

The principal witness therefore tests simultaneous satisfiability of

$$\begin{aligned} & \text{StrictTotalOrder}(\mathbb{N}_0, <), \quad \text{NonTerminatingCosmicSuccession}_C(\mathbb{N}_0, <), \quad \text{CSPP}, \\ & \text{CMA}, \quad \text{UCC}, \quad \text{CRP}, \quad \text{IdentityRealizationConvexity}, \\ & \text{AFB}, \quad \text{UEIE}, \quad \text{PIECP}, \end{aligned} \quad (1012)$$

together with the complete V38/F18 physical-realization profile construction.

The construction is only a satisfiability witness. Its countable population, two-member identity

ranges, state assignments, and any optional successor links are not proposed as a physical cosmology.

53.11 The V38 realization profile is a conservative construction

Suppose all component functions:

$$\mathcal{S}_{\text{phys}}(s), \quad \mathfrak{X}_C(s), \quad \mathfrak{D}_C(s), \quad \mathfrak{G}_C(s) \quad (1013)$$

are already fixed.

Then:

$$\mathfrak{R}_C(s) \quad (1014)$$

is uniquely fixed by definition.

Therefore:

$$\text{ComponentInterpretationsFixed} \implies \text{RealizationProfileUniquelyDetermined} . \quad (1015)$$

The profile introduces no additional independent truth assignment.

In particular, the profile is not a temporal primitive:

$$\mathfrak{R}_C(s) \not\equiv_{\text{type}} \text{TemporalPrimitive} . \quad (1016)$$

53.12 Profile Coverage and State Plurality

Consider two qualified systems A and B realized at the same stage s .

Let:

$$\Omega_A = \mathbb{R}, \quad \Omega_B = \mathbb{R}^3. \quad (1017)$$

Assign:

$$X_A(s) = 1, \quad X_B(s) = (0, 1, 2). \quad (1018)$$

The complete state profile:

$$\mathfrak{X}_C(s) = (A \mapsto 1, B \mapsto (0, 1, 2)) \quad (1019)$$

is well defined.

Yet:

$$\Omega_A \neq \Omega_B. \quad (1020)$$

Therefore:

$$\text{CompleteStateProfileCoverage} \not\models \text{OneUniversalPhysicalStateSpace}. \quad (1021)$$

53.13 Change Coverage and System-Specific Codomains

Let:

$$\Xi_A = \mathbb{R}, \quad \Xi_B = \mathbb{R}^2. \quad (1022)$$

Assign actual change to both systems.

Then:

$$\mathcal{B}_\Delta(s) = \mathcal{S}_{\text{phys}}(s) = \{A, B\} \quad (1023)$$

may hold while:

$$\Xi_A \neq \Xi_B. \quad (1024)$$

Thus:

$$\mathcal{B}_\Delta(s) = \mathcal{S}_{\text{phys}}(s) \not\models \exists \Xi_{\text{univ}} \forall X \in \mathcal{S}_{\text{phys}}(s), \quad \Xi_X = \Xi_{\text{univ}}. \quad (1025)$$

53.14 Composition does not imply cross-level change identity

Let:

$$A \triangleleft_{\kappa, s} B. \quad (1026)$$

Assign:

$$\Xi_A = \mathbb{R}, \quad \Xi_B = \mathbb{R}^3. \quad (1027)$$

Under UCC both systems change.

Nevertheless:

$$\Delta_A^{\text{phys}}(s) \not\equiv_{\text{type}} \Delta_B^{\text{phys}}(s). \quad (1028)$$

Hence:

$$A \triangleleft_{\kappa, s} B \not\models \Delta_A^{\text{phys}}(s) \equiv_{\text{type}} \Delta_B^{\text{phys}}(s). \quad (1029)$$

53.15 Composition does not imply cross-level causal determination

Consider two typed structures $\mathfrak{M}_1$ and $\mathfrak{M}_2$ with the same:

$$A, \quad B, \quad s, \quad A \triangleleft_{\kappa, s} B, \quad X_A(s), \quad X_B(s), \quad \Delta_A^{\text{phys}}(s). \quad (1030)$$

Let the structures differ only in the admissible causal realization assigned to B :

$$\mathcal{C}_{B,1}^{\text{act}}(s) \neq \mathcal{C}_{B,2}^{\text{act}}(s). \quad (1031)$$

Both may satisfy CRP.

Therefore the composition relation alone does not determine the composite causal profile:

$$A \triangleleft_{\kappa,s} B \not\models \mathcal{C}_B^{\text{act}}(s) = F_{\kappa} \left(\mathcal{C}_A^{\text{act}}(s) \right). \quad (1032)$$

Any such F_{κ} requires additional physical premises.

53.16 Common-stage co-realization does not entail interaction

Let:

$$A, B \in \mathcal{S}_{\text{phys}}(s) \quad (1033)$$

and retain CMA.

Assign:

$$\neg \text{PhysicalInteraction}(A, B; s). \quad (1034)$$

This does not violate CMA.

Hence:

$$\text{CMA} \not\models \text{UniversalPairwisePhysicalInteraction}. \quad (1035)$$

Likewise assign:

$$\neg \text{SignalAccessible}(A, B; s). \quad (1036)$$

Then:

$$\text{CMA} \not\models \text{UniversalInstantaneousSignalAccessibility}. \quad (1037)$$

53.17 Population transformation does not require adjacent stages

Take:

$$0 \prec_C 1 \prec_C 2. \quad (1038)$$

Compare the nonadjacent endpoints:

$$r = 0, \quad s = 2. \quad (1039)$$

The sets:

$$\mathcal{P}_{0,2}, \quad \mathcal{N}_{0 \rightarrow 2}, \quad \mathcal{L}_{0 \rightarrow 2}, \quad \mathcal{T}_{0,2} \quad (1040)$$

remain well defined.

Therefore:

$$\text{PopulationTransformationDescriptorDefined}(r, s) \not\vdash \text{Adjacent}(r, s). \quad (1041)$$

53.18 Population transformation does not imply population motion

The pairwise descriptor is constructed entirely from correctly typed identity-domain membership statements of the form

$$A \in \mathcal{U}_{\text{phys}}, \quad u \in \mathcal{S}_{\text{C}}^{\text{tot}}, \quad \nu \in I_A, \quad (1042)$$

with ν instantiated by the selected endpoints or, where required by $\mathcal{T}_{r,s}$, by an intermediate common cosmic change stage.

No motion predicate occurs in its definition.

Thus:

$$\text{Defined}(\mathfrak{P}_{\text{C}}^{\text{pop}}(r, s)) \not\vdash \text{PopulationMovesFrom}(r, s). \quad (1043)$$

53.19 Successorship does not imply population conservation

The direct-successor definition constrains only those candidate relations that are actually asserted. It neither requires every ending to have a successor nor requires every later entrant to be a successor, and it imposes no one-to-one correspondence between departing and newly realized populations. Therefore

$$\text{Defined}(\text{SuccAt}) \not\Rightarrow \text{PopulationConservationLaw}. \quad (1044)$$

An ending may produce several successors, one successor, or none, while independently formed systems may enter the later population without being successors of an identity that ended in the selected interval.

53.20 Operational Metrics Do Not Imply Temporal Identity

Consider two physically admissible calibration conventions:

$$m_P = \mathcal{M}_P^{\text{op}}(r_1, r_2; \kappa_P), \quad (1045)$$

$$m'_P = 2m_P. \quad (1046)$$

The two representations may encode the same ordered physical records under different unit scales.

The universal cosmic ordering is unchanged.

Thus:

$$m_P \neq m'_P \not\Rightarrow \text{DifferentTemporalReferents}(P, P'). \quad (1047)$$

More importantly:

$$\text{OperationalMetricSuccessfullyConstructed} \not\vdash m_P \equiv_{\text{type}} T_{\text{ITOF}}. \quad (1048)$$

53.21 Model Success Does Not Confer Temporal Identity

Let one application model use parameter:

$$\lambda \quad (1049)$$

and an equivalent reparameterization use:

$$\lambda' = 2\lambda. \quad (1050)$$

Suppose both representations predict exactly the same physical observables after the corresponding transformation of the model equations.

Then:

$$\text{Success}(\lambda) \wedge \text{Success}(\lambda'). \quad (1051)$$

Operational success alone cannot identify both distinct numerical parameters with the same temporal referent.

Therefore:

$$\text{SuccessfulEvolutionParameter} \not\vdash \text{TemporalIdentity}. \quad (1052)$$

53.22 Non-injective observation remains possible

Let:

$$s_0 \prec_C s_1 \prec_C s_2 \prec_C s_3 \quad (1053)$$

belong to I_A .

Define:

$$\mathcal{O}_{P,\varepsilon} : I_A \longrightarrow \{0, 1\} \quad (1054)$$

with:

$$\mathcal{O}_{P,\varepsilon}(s) = \begin{cases} 0, & \text{Response}_P(A; s) < \varepsilon, \\ 1, & \text{Response}_P(A; s) \geq \varepsilon. \end{cases} \quad (1055)$$

Suppose:

$$\mathcal{O}_{P,\varepsilon}(s_0) = \mathcal{O}_{P,\varepsilon}(s_1) = 0 \quad (1056)$$

and:

$$\mathcal{O}_{P,\varepsilon}(s_2) = \mathcal{O}_{P,\varepsilon}(s_3) = 1. \quad (1057)$$

Then the map is non-injective.

Therefore:

$$\mathcal{O}_{P,\varepsilon}(s) = 1 \not\Rightarrow \text{ExactCosmicChangeStageIdentified}(s). \quad (1058)$$

This remains one formal source of Exact-Change-Stage Restraint.

53.23 State reconstruction does not identify a unique stage

Suppose:

$$\hat{X}_{A;P,M}(r) = X^*. \quad (1059)$$

If:

$$\exists s_1, s_2 \in I_A, \quad s_1 \neq s_2, \quad X_A(s_1) = X_A(s_2) = X^*, \quad (1060)$$

then:

$$\text{UniqueSelectedStateReconstruction} \not\Rightarrow \text{UniqueCosmicChangeStageIdentification}. \quad (1061)$$

State recurrence and exact cosmic-stage identity remain distinct.

53.24 Model failure is not foundational failure

Suppose:

$$M_1 \neq M_2 \quad (1062)$$

and:

$$\text{DiscriminationFavours}(M_1). \quad (1063)$$

Let both models contain application-level bridge assumptions not deductively fixed by their respective foundational commitments.

Then model discrimination establishes:

$$\text{ApplicationModelSupportOrRestriction} \quad (1064)$$

without logically isolating a foundational premise.

Therefore:

$$\text{ModelDiscrimination} \not\vdash \text{FoundationalAttribution} . \quad (1065)$$

The additional attribution burden of Section 25 is therefore non-redundant.

53.25 CMA and UCC in the V38 dependency architecture

CMA and UCC are logically distinct; the stagewise form of UCC follows from the population definition, as shown by the direct quantifier conversion in Eqs. (1000)–(1001). The distinction is non-causal and preserves the separate roles of the two statements definitionally.

53.26 Current principal modular non-entailments

The identity, lifecycle, causal, application, and representation modules remain separated unless an explicit dependency is stated. Every retained formal non-derivability claim requires a corresponding witness or admissible modular extension. Ordinary non-transfer claims use $\nRightarrow$ rather than $\not\vdash$.

53.27 Current direct derivations

V38/F18 also preserves genuine derivations.

From strict total ordering:

$$r \prec_C s \implies \neg(s \prec_C r) . \quad (1066)$$

From Non-Terminating Cosmic Succession:

$$\text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \implies \nexists g \in \mathcal{S}_C^{\text{tot}} \text{ Greatest}_{\prec_C}(g) . \quad (1067)$$

Because unlimited future extent is not part of temporal admissibility, infinity of the stage domain follows only conditionally when the additional cosmological non-termination condition is adopted:

$$\begin{aligned} &\text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \\ &\wedge \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \implies \text{Infinite}(\mathcal{S}_C^{\text{tot}}) . \end{aligned} \quad (1068)$$

From AFB and the UCC:

$$\text{AFB} \wedge \text{UCC} \implies \forall A \in \mathcal{U}_{\text{phys}}, \quad \text{FormationChange}_A(f_A) . \quad (1069)$$

This derived statement concerns physical change of A at its identity-range boundary only. It does not order that change ahead of or behind the changes of other qualified systems sharing the same common cosmic stage.

From ending and the UCC:

$$\text{End}_A(e) \wedge \text{UCC} \implies \text{PhysReal}_A^+(e). \quad (1070)$$

From UCC and CRP:

$$\text{UCC} \wedge \text{CRP} \implies \forall A \in \mathcal{U}_{\text{phys}} \forall s \in I_A, \quad \mathcal{C}_A^{\text{act}}(s) \neq \emptyset. \quad (1071)$$

From CSPP, CMA, and UCC:

$$\forall s \in \mathcal{S}_C^{\text{tot}}, [\mathcal{S}_{\text{phys}}(s) \neq \emptyset \wedge \text{CosmicCoPresence}_C(\mathcal{S}_{\text{phys}}(s); s) \wedge \mathcal{B}_\Delta(s) = \mathcal{S}_{\text{phys}}(s)]. \quad (1072)$$

From temporal admissibility, CMA, UCC, and CRP, Eq. (169) supplies the corresponding nonempty stage-relative population, local stage-change condition, and nonempty causal realization for every member. This identifies the causal completion of the governing common-stage realization without adding a new independent universal postulate or realization predicate.

54. Governing Equation Reference

The following register identifies the principal equations that determine the architecture of V38/F18.

Table 3: Principal governing equations of V38/F18.

Role	Reference	Status
Definition of time	Eq. (10)	Governing ordered-pair denotation with explicit formal-symbolic stage meaning.
Governing earlier–later designation	Eq. (20)	Meaning-fixing semantic designation of $\prec_C$; not supplied by the strict-order axiom.
Strict Cosmic Ordering	Eq. (21)	Foundational axiom constraining the designated earlier–later relation as a strict total order.
Non-Terminating Cosmic Succession	Eq. (14)	Conditional cosmological non-termination condition: every admitted cosmic stage has a later stage. It is non-metric and directly evaluable once adopted, but it is not assumed as a fact about the unknown complete future.

Role	Reference	Status
Temporal-extension admissibility	Eq. (19)	Defined condition: nonempty formal cosmic-stage domain + Strict Cosmic Ordering + objective realized-change stage semantics for every admitted member + at least one nontrivial earlier–later pair. CSPP follows as a derived population consequence; CMA and UCC remain logically distinct under the one-global-stage definitions, and Non-Terminating Cosmic Succession is optional.
Order-representation non-metricity	Eqs. (36)–(37)	Derived representation-level result; no canonical metric interval follows from order preservation.
Cosmic physical totality	Eqs. (46)–(57)	Defines the stage-supported physical-factor component, its stage-relative population, and the physical universe as the typed totality of physical-system identities and physically realized physical factors, excluding both container semantics and a silent retyping of the totality as one physical-system identity.
Physical-system totality	Eq. (54)	Definition of the governing ontic system-identity totality.
Identity-realization range	Eq. (59)	Definition; a restriction of the common formal cosmic-stage domain, not a private time.
Stage-relative population	Eq. (60)	Definition from memberwise identity realization.
Stage-relative cosmic physical totality	Eqs. (47)–(61)	Defined stage-relative typing of realized non-system physical factors and their typed union with the realized physical-system population; these definitions do not alter CMA or UCC quantification over qualified systems.
CSPP	Eq. (64)	Derived population principle following from governing realized-change stage semantics.

Role	Reference	Status
CMA	Eq. (69)	Governing foundational axiom requiring objective common-stage co-presence of the complete then-realized qualified physical-system population at each admitted member; it is distinct from UCC and does not itself impose complete actual-change coverage.
UCC	Eq. (78)	Independent foundational physical postulate requiring system-specific actual physical change at every member of each realized identity range. It remains logically distinct from CMA and supplies no common-stage co-presence claim.
Actual-change subset	Eq. (76)	Definition.
Complete-population change coverage	Eq. (93)	Distinct conjunction with UCC.
System-change profile	Eq. (101)	Defined construction.
Local stage-change condition	Eq. (98)	Defined local representation of complete-population change coverage in the already common global-stage co-presence and complete-population actual-change coverage.
State profile	Eq. (118)	Defined construction.
CRP	Eq. (135)	Independent foundational physical postulate.
Causal-realization profile	Eq. (140)	Defined construction.
Complete physical-realization profile	Eq. (149)	Defined construction.
Relationally augmented realization profile	Eq. (159)	Application-level extension of the complete-population realization profile.
Hierarchical constituent relation	Eq. (172)	Current typed physical relation.

Role	Reference	Status
Class-indexed identity-qualification profile	Eqs. (197)–(198)	Current V38/F18 application-admissibility formalization of class-specific physical-system identity qualification; its governing status is entirely current-version status.
Physical history	Eq. (218)	Formal representation.
Identity ending	Eq. (247)	Definition.
PIECP	Eq. (261)	Independent ending-specific causal postulate.
UEIE	Eq. (268)	Optional independent lifecycle postulate; not a governing core requirement.
Direct successor	Eq. (275)	Defined physically produced new-identity relation.
Endpoint-persistent population	Eq. (286)	Current definition.
Later-endpoint entrant population	Eq. (289)	Current definition.
Earlier-endpoint departing population	Eq. (292)	Current definition.
Intermediate-only identities	Eq. (298)	Current definition.
System-specific physical directionality	Eqs. (352)–(358)	Current criterion-indexed physical construction; not a temporal-order identity.
Operational metric map	Eq. (366)	Application-level construction.
Exact-Change-Stage Restraint	Eqs. (417), (418), and (419)	Epistemic principle.
Generalized Non-Transfer Principle	Eq. (526)	Foundational type principle.
Relativistic temporal nonidentity	Eq. (547)	Direct external type position.
ITOF–relativistic comparison bridge	Eq. (695)	Application-level empirical-comparison architecture.

Role	Reference	Status
Bridge-robust separation margin	Eq. (724)	Methodological comparison quantity over independently admissible bridge classes.
Foundational discrimination burden	Eq. (740)	Methodological inferential condition.

55. Framework Identity and Extension Boundary

55.1 Identity-preserving temporal conditions

A physical extension or application presented as V38/F18-admissible must preserve the temporal identity fixed by Eq. (10).

It must preserve the designated earlier–later meaning, Strict Cosmic Ordering, and the realized-change semantics of admitted stages. A model that additionally adopts Non-Terminating Cosmic Succession must preserve the exact conditional meaning of Eq. (14), but adopting that cosmological condition is not required for framework identity.

An application that replaces the temporal referent with another quantity is not an identity-preserving V38/F18 application.

55.2 Identity-preserving realization conditions

An identity-preserving V38/F18 realization preserves governing CMA, UCC, and the identity-range and stage-population definitions that keep common-stage co-presence distinct from system-specific physical-change actuality. CSPP remains the derived population consequence of temporal admissibility and is not promoted to an independent realization condition. Applications containing actual system endings must preserve the conditional direct-successor criterion rather than imposing universal successor production. If optional cosmic non-termination is adopted, it remains a separate cosmological premise rather than part of the realization core.

The local $\text{StageChangeBridge}_C(s)$ remains only a defined conjunction of CMA common-stage co-presence and UCC complete-population actual-change coverage at an admitted stage. It creates no additional temporal layer, causal content, or dynamical mechanism.

55.3 Identity-preserving physical typing

An admissible extension must preserve the distinction between:

$$\begin{aligned}
 &\text{time,} \quad \text{cosmic physical totality,} \quad \text{common cosmic change stage,} \\
 &\text{physical system,} \quad \text{physical state,} \quad \text{physical change,} \quad \text{physical factor,} \\
 &\quad \text{causal contributor,} \quad \text{physical history,} \quad \text{record,} \\
 &\text{operational metric,} \quad \text{coordinate,} \quad \text{model parameter,} \quad \text{model geometry.}
 \end{aligned} \tag{1073}$$

In particular, the extension must preserve the causal-source boundary:

$$T_{\text{ITOF}} \not\equiv_{\text{type}} \text{PhysicalCausalContributor} . \quad (1074)$$

55.4 Identity-preserving physical-realization architecture

A V38/F18 application may refine the physical content represented inside:

$$\mathfrak{R}_C(s) \quad (1075)$$

and may add independently warranted model-relative relations through $\mathfrak{R}_C^{[M]}(s)$. Neither construction may be reinterpreted as time.

Thus:

$$\mathfrak{R}_C(s) \not\equiv_{\text{type}} T_{\text{ITOF}} \quad (1076)$$

is identity-preserving.

Likewise, a specific application may introduce additional physical relations not included in the profile.

Their introduction does not require expansion of the temporal ordered pair.

55.5 What may vary

Subject to physical warrant, explicit typing, parameter provenance, and appropriate empirical evaluation, V38/F18 permits variation in:

$$\begin{aligned} & \text{SystemClass, SystemBoundary, IdentityCriterion,} \\ & \text{CompositionCriterion, StateSpace, ChangeContentType,} \\ & \text{PhysicalDynamics, CausalModel, ComparisonMap,} \\ & \text{SignalModel, ObservationModel, ClockResponseModel,} \\ & \text{OperationalMetric, ExperimentalProtocol.} \end{aligned} \quad (1077)$$

No single application model is permanently built into the definition of time.

55.6 What would constitute a foundational revision

The following substitutions would alter the governing identity of V38/F18 rather than constitute ordinary application-level extension:

$$\begin{aligned}
T_{\text{ITOF}} &\longrightarrow \text{ClockOutput}, \\
T_{\text{ITOF}} &\longrightarrow \text{CoordinateTime}, \\
T_{\text{ITOF}} &\longrightarrow \text{MetricInterval}, \\
T_{\text{ITOF}} &\longrightarrow \text{ProperTimeFunctional}, \\
T_{\text{ITOF}} &\longrightarrow \text{PhysicalRealizationProfile}, \\
\mathfrak{U}_C^{\text{phys}} &\longrightarrow \text{PhysicalContainer}, \\
\mathfrak{U}_C^{\text{phys}} &\longrightarrow \text{PhysicalSystemIdentity}, \\
\text{OneCommonCosmicStageTotality} &\longrightarrow \text{IndependentPerSystemTimes}, \\
\text{PhysicalCausation} &\longrightarrow \text{TimeAsCauseOfChange}, \\
\text{HistoricalPhysicalAccumulation} &\longrightarrow \text{FourthPhysicalCausalSource}.
\end{aligned} \tag{1078}$$

Removal or alteration of a governing axiom, constitutive condition, or derived definition that fixes the V38/F18 architecture—including Strict Cosmic Ordering, realized-change stage semantics, the non-container cosmic physical-totality distinction, governing CMA, or the UCC continuity condition—would constitute a foundational revision rather than an admissible application-level extension. Changing the definition of the optional Non-Terminating Cosmic Succession predicate would likewise revise its declared cosmological module, but a finite-extent application is not excluded merely for not assuming that optional condition.

55.7 Admissible extension condition

Let E be a proposed extension.

Define the structural admissibility burden:

$$\begin{aligned}
\text{AdmissibleExtension}_{38}(E) &\implies \text{TemporalCorePreserved}(E) \\
&\quad \wedge \text{CommonStageArchitecturePreserved}(E) \\
&\quad \wedge \text{CMAUCCDependencyPreserved}(E) \\
&\quad \wedge \text{PhysicalTypingExplicit}(E) \\
&\quad \wedge \text{IdentityCriteriaExplicitWhereUsed}(E) \\
&\quad \wedge \text{CausalTypingPreserved}(E) \\
&\quad \wedge \text{NonTransferPreserved}(E) \\
&\quad \wedge \text{ProvenanceDeclared}(E).
\end{aligned} \tag{1079}$$

Where E produces an empirical prediction:

$$\text{PredictiveExtension}_{38}(E) \implies \text{AdmissibleExtension}_{38}(E) \wedge \text{PredeclaredEmpiricalProtocol}(E). \tag{1080}$$

Where foundational discrimination is claimed, the stronger attribution burden also applies.

56. Scientific Claim Boundary

56.1 Formal countercondition and empirical procedure

V38/F18 retains the governing distinction:

$$\text{FormalCountercondition}(F) \not\equiv_{\text{def}} \text{DirectFiniteExperimentFor}(F). \quad (1081)$$

A formal contrary states what would contradict a commitment.

An empirical procedure specifies how physical evidence may warrant that contrary.

The existence of the first does not guarantee the second.

56.2 Universal commitments and finite evidence

For universal foundational statement F :

$$\text{FinitePositiveObservations} \not\Rightarrow \text{DeductiveProof}(F). \quad (1082)$$

Likewise:

$$\text{FiniteNullObservation} \not\Rightarrow \text{PhysicalCounterexample}(F). \quad (1083)$$

The inferential relation depends on what the observation actually establishes.

56.3 Application-level failure

For application model M , let:

$$\mathfrak{P}_M^* \quad (1084)$$

be its predeclared evaluation protocol.

Advance-prediction status requires:

$$\begin{aligned} \text{AdvancePrediction}(M) \implies & \text{ProtocolFrozen}(\mathfrak{P}_M^*) \\ & \wedge \text{IndependentParameterProvenance}(M) \\ & \wedge \text{NoEvaluationLeakage}(\mathfrak{P}_M^*, D_M). \end{aligned} \quad (1085)$$

If the prediction fails under the declared rule:

$$\text{ApplicationModelRejectedOrRestricted}(M, D_M) \quad (1086)$$

is the immediate conclusion.

56.4 Foundation-level failure

A failed observable reaches foundational commitment F only where:

$$F \wedge B_F^{\text{phys}} \wedge B_F^{\text{obs}} \wedge \mathcal{P}_F^{\text{aux}} \vdash O_F \quad (1087)$$

and the failed result cannot be assigned to an independently unsettled bridge, auxiliary, measurement, parameter, approximation, or uncertainty component.

Thus:

$$\neg O_F + \text{AttributionIdentifiableTo}(F) \implies \text{FoundationalChallenge}(F). \quad (1088)$$

Without attribution identifiability:

$$\neg O_F \not\Rightarrow \neg F. \quad (1089)$$

56.5 Post-hoc revision status

The no-post-hoc rule of Eq. (504) remains applicable: a scientifically legitimate revised model does not alter the historical status of the original advance prediction and requires new independent evaluation.

56.6 Bounded support

Where a predeclared test favours application model M :

$$\text{DiscriminationFavours}(M, D) \implies \text{Warrant} [\text{PhysicalApplicationModelSupportedOn}(M, D)]. \quad (1090)$$

The conclusion remains bounded to the inferential level actually tested.

It does not automatically establish:

$$\text{DiscriminationFavours}(M, D) \not\Rightarrow \text{OperationalQuantityIsTime}. \quad (1091)$$

or every universal foundational commitment.

56.7 Final scientific inference rule

The governing scientific discipline is:

Scientific inference propagates only through explicitly declared logical dependency, a typed physical application chain, observational support, (1092) uncertainty structure, and warranted evidential scope.
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57. V38/F18 Modular Architecture

57.1 Time-definition module

Define

$$\mathfrak{T}_{\text{ref}}^{38} = \left\{ \mathcal{S}_C^{\text{tot}}, \prec_C, T_{\text{ITOF}} \right\}. \quad (1093)$$

This module collects the symbols used in the formal definition of time. The stage members are formal expressions of realized physical change within the universal objective earlier–later cosmic succession. Physical systems are not components of the ordered pair, but actual physical-change realization is part of the semantic admission condition for a stage; no dynamical law or independent stage object is thereby inserted into T_{ITOF} .

57.2 Temporal Admissibility and Conditional Extent

Define

$$\begin{aligned} \mathfrak{T}_{\text{adm}}^{38} = \left\{ \mathcal{S}_C^{\text{tot}} \neq \emptyset, \text{StrictTotalOrder}(\mathcal{S}_C^{\text{tot}}, \prec_C), \right. \\ \left. \forall s \in \mathcal{S}_C^{\text{tot}} \text{ RealizedChangeStage}_C(s), \quad \exists r, t \in \mathcal{S}_C^{\text{tot}} (r \prec_C t), \right. \\ \left. \text{TemporalExtensionAdmissible}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \right\}. \end{aligned} \quad (1094)$$

These entries are exactly the contents compressed by governing temporal admissibility. The separate cosmological extension condition is

$$\mathfrak{T}_{\text{extent}}^{38} = \left\{ \text{NonTerminatingCosmicSuccession}_C(\mathcal{S}_C^{\text{tot}}, \prec_C) \right\}, \quad (1095)$$

and is optional because the complete future extent of physical change is not scientifically fixed by the framework. The stage-realization entry supplies semantic physical actuality, not a system state profile or dynamical law.

For organizational reference,

$$\mathfrak{T}_{\text{temporal}}^{38} = \mathfrak{T}_{\text{ref}}^{38} \cup \mathfrak{T}_{\text{adm}}^{38}, \quad \mathfrak{T}_{\text{extent}}^{38} \text{ remains a conditional cosmological module.} \quad (1096)$$

The union is organizational: ordered-pair identification and admissibility remain distinct statement roles even though both concern the temporal foundation. Conditional future extent is intentionally kept outside that union.

57.3 Common physical-realization module

Define:

$$\begin{aligned} \mathfrak{T}_{\text{real}}^{38} = \{ & \mathfrak{U}_C^{\text{phys}}, \quad \mathfrak{F}_{\text{phys}}, \quad \mathcal{U}_{\text{phys}}, \quad I_A, \quad \mathcal{S}_{\text{phys}}(s), \quad \text{CSPP}, \quad \text{CMA}, \quad \text{UCC}, \\ & \mathcal{B}_\Delta(s), \quad \text{StageChangeBridge}_C(s), \\ & \mathfrak{X}_C(s), \quad \mathfrak{D}_C(s), \\ & \mathfrak{G}_C(s), \quad \mathfrak{R}_C(s) \}. \end{aligned} \quad (1097)$$

$\mathfrak{U}_C^{\text{phys}}$ fixes the non-container meaning of the physical universe as the totality of physical systems and physically realized physical factors; it is not a temporal component and is not itself a system identity. CSPP, CMA, and UCC retain distinct statement roles: CSPP is the derived population principle supplied by realized-change stage semantics; CMA is the common-stage co-presence axiom; and UCC is the independent system-specific physical-change continuity postulate. Their conjunction, together with admitted stage semantics, supplies the defined full-theory common-cosmic-change-stage role without introducing a new primitive or causal law. StageChangeBridge_C(*s*) is a defined local representation, not a new primitive. The non-termination belongs to the separate cosmological-extent branch rather than the realization core. CRP belongs to the causal module even though its output contributes to the complete physical-realization profile.

57.4 Composition module

Define:

$$\mathfrak{T}_{\text{comp}}^{38} = \{ \triangleleft_{\kappa, s}, \mathfrak{R}_C(s), \text{CrossLevelNonTransfer} \}. \quad (1098)$$

57.5 Identity-history module

Define:

$$\begin{aligned} \mathfrak{T}_{\text{id}}^{38} = \{ & \text{IdentityRealizationConvexity}, \text{AFB}, \mathfrak{Q}_K^{\text{id}}, X_A, \mathcal{H}_A, \\ & \text{HistoricalPhysicalAccumulation}_A^{\leq s}, \text{CumulativePhysicalResultThrough}_A(s) \}. \end{aligned} \quad (1099)$$

57.6 Lifecycle module

Define the governing lifecycle module by

$$\mathfrak{T}_{\text{life}}^{38} = \{ \text{End}_A(e), \Delta_A^{\text{end}}(e), \text{PIECP}, \text{SuccAt}(A, B; e), \mathfrak{S}^+(A, e) \}. \quad (1100)$$

UEIE has lifecycle type but is not included as a governing truth commitment in this module; it enters only when the optional postulate of Eq. (268) is explicitly adopted.

57.7 Population-transformation module

Define:

$$\mathfrak{T}_{\text{pop}}^{38} = \{\mathcal{P}_{r,s}, \mathcal{N}_{r \rightarrow s}, \mathcal{L}_{r \rightarrow s}, \mathcal{T}_{r,s}, \mathfrak{P}_C^{\text{pop}}(r, s)\}. \quad (1101)$$

57.8 Representation and physical-model module

Define:

$$\begin{aligned} \mathfrak{T}_{\text{model}}^{38} = \{ & \text{AdmissiblePhysicalModel}, \mathcal{B}_M^{\text{in}}, \text{Dyn}_M, \mathcal{B}_M^{\text{out}}, \\ & \text{ModelEvolutionParameter}, \text{CrossSystemComparison}, \mathfrak{A}_{A,\alpha}, \text{ArrowAligned}_{A,\alpha}, \mathcal{M}^{\text{op}}, \\ & \mathfrak{Q}_{\text{MD}}, \text{PredictiveSeparationScreen}\}. \end{aligned} \quad (1102)$$

57.9 Observation module

Define:

$$\mathfrak{T}_{\text{obs}}^{38} = \{\mathcal{L}_P, \text{ManifestationAt}, \mathcal{O}, \mathcal{B}_{P,M}^{\text{obs}}, J_r^{\text{phys}}, \text{ExactChangeStageRestraint}\}. \quad (1103)$$

57.10 Empirical bridge module

Define:

$$\mathfrak{T}_{\text{emp}}^{38} = \{\mathfrak{P}^*, \text{FoundationalEmpiricalBridge}, \text{FoundationalAttribution}, \text{PredictionSeparation}\}. \quad (1104)$$

57.11 External-theory and Non-Transfer module

Define:

$$\mathfrak{T}_{\text{ext}}^{38} = \{\text{NTP}, \mathcal{Q}_{\text{rel}}, \mathfrak{B}_{I:R}^{P,D}, \delta_{I:R}^{P,D}\}. \quad (1105)$$

57.12 Governing modular architecture

The governing V38/F18 architecture, excluding the optional Cosmic Origin augmentation, may be represented as an ordered family of typed modules:

$$\begin{aligned} \mathfrak{V}_{\text{V38}}^{\text{gov}} := \langle & \mathfrak{T}_{\text{temporal}}^{38}, \mathfrak{T}_{\text{real}}^{38}, \mathfrak{T}_{\text{comp}}^{38}, \mathfrak{T}_{\text{id}}^{38}, \mathfrak{T}_{\text{life}}^{38}, \\ & \mathfrak{T}_{\text{pop}}^{38}, \mathfrak{T}_{\text{model}}^{38}, \mathfrak{T}_{\text{obs}}^{38}, \mathfrak{T}_{\text{emp}}^{38}, \mathfrak{T}_{\text{ext}}^{38} \rangle. \end{aligned} \quad (1106)$$

The tuple records modular organization only. It does not collapse the distinct statement statuses of the objects contained in those modules and does not imply that the modules share one physical

or ontological type.

If Cosmic Origin is included as the separately stated optional cosmological module, define the augmented architecture by:

$$\mathfrak{F}_{V38}^{(+Origin)} := \langle \mathfrak{F}_{V38}^{gov}, \text{CosmicOrigin} \rangle. \quad (1107)$$

The full framework tuple is not the definition of time:

$$\mathfrak{F}_{V38}^{gov} \not\equiv_{\text{def}} T_{\text{ITOF}}. \quad (1108)$$

58. Reference Architecture and Authority

The governing historical sequence of ITOF is documented through the project's versioned manuscripts and consolidated archive records.

V37/F17 is the immediate foundational predecessor of V38/F18 [1].

The broader project archive records the earlier historical sequence and permits older definitions, dependencies, and formulations to be distinguished from the present governing theory [3].

The reference basis therefore comprises:

$$\begin{aligned} &\text{ImmediateV37Predecessor,} \\ &\text{ConsolidatedHistoricalITOFRecord,} \\ &\text{ExternalScientificLiterature.} \end{aligned} \quad (1109)$$

The first identifies the immediate historical predecessor; it supplies provenance, not current governing authority.

The second preserves historical traceability.

The third supplies external scientific and mathematical context where relevant.

No earlier ITOF version overrides a governing V38/F18 statement merely by historical priority.

Likewise, external scientific literature is not cited as authority for the definition of time.

It is used where external physical models, measurements, mathematical constructions, experimental records, or competing interpretations are discussed.

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