Invariant Temporal Ordering Framework V29/F9: The Comprehensive Governing Synthesis of Universal Cosmic Succession, Physical Identity, Transformation, Spatial Realization, and Cross-Domain Application

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Abstract

The Invariant Temporal Ordering Framework V29/F9 presents the long-term governing synthesis of ITOF. It defines time as the universal ordering and succession of common cosmic stages in one common cosmic extension, represented by $T_{\text{ITOF}} = (\mathcal{S}_C, \prec_C)$. Time does not denote matter, energy, a field, a force, a coordinate, a metric interval, a proper-time functional, a clock output, a moving carrier, or a causal participant in physical change. The fixed and irreversible relation $\prec_C$ orders one common stage domain shared by every physical bearer whose identity is then realized.

The Cosmic Moment Axiom applies at every actual common cosmic stage, including the unique actual first cosmic stage: every then-existing physical system is present there and undergoes its own bearer-specific positive physical realization. Each bearer has one identity-bounded physical history, $\mathcal{H}_A = (I_A, \prec_C|_{I_A}, X_A)$, with one unique formation member and one unique ending member; one-stage histories remain admissible. Functional failure is distinguished from identity ending. Every attained non-terminal ending has a physically continuous outcome, but only identity-producing endings form successor identities; an ending may instead or additionally contribute to already existing bearers.

V29/F9 integrates spatial realization, place, motion, local cycles, clocks, observation, remote records, historical reconstruction, prediction, and restricted empirical testing without assigning temporal agency to any of them. Place denotes spatial position, extent, or relation rather than an independent bearer. Motion is change in bearer position or spatial relations, not movement through time. Clocks generate standardized physical records rather than measure time ontologically. Source occurrence, propagation, reception, record formation, reading, and inference remain distinct, and finite records do not automatically identify one exact cosmic stage.

The framework is empirically accountable through bearer-specific identity criteria, validated record chains, preregistered restricted hypotheses, positive and adverse decision rules, and explicit counterinstance conditions for UCC. It directly rejects relativistic temporal ontology: coordinates, metric intervals, proper-time functionals, spacetime geometries, and clock outputs are not time

as defined by ITOF. Predictive or calculational success does not transfer temporal identity, while any proposed ITOF account of accepted observations retains an independent quantitative burden. V29/F9 is intended as the governing foundational reference unless a substantial new foundational issue, internal contradiction, or decisive physical challenge requires reconstruction.

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Comprehensive Notation and Symbol Register

This independent register consolidates the governing, recurrent, and cross-sectional notation used in V29/F9. It is navigational rather than constitutive: the definitions, axioms, principles, propositions, and application bridges in the main text remain governing. Standard mathematical symbols and one-use local variables remain defined where introduced; the register includes the framework-level symbols and recurrent application families needed to read the manuscript without reconstructing their meanings from dispersed sections.

Symbol or notation	**Meaning and governing scope**
General indexing and logical conventions	
A, B, X, Y	Physical bearers unless a local definition states otherwise. C commonly denotes a clock, S a source, D a detector or declared study domain, and R a spatial reference bearer.
$r, s, t, u, v, a, e, f, g$	Common cosmic-stage variables. By recurrent convention, f and f_A denote formation stages, e and e_A ending stages, a a reference stage, and g a candidate greatest stage.
$P, M, F, \Sigma, \Gamma, \kappa$	Respectively a protocol, model, frame or convention, representation scheme, declared comparison or identity criterion, and a criterion parameter. Their exact domains are fixed locally.
$\widehat{(\cdot)}$	Protocol-, model-, or record-conditioned estimate or reconstruction; it is not identical with the corresponding ontic object.
$(\cdot)\vert_J$, $\prec_C \vert_{I_A}$	Restriction of a map or relation to the declared domain J or identity domain I_A.
$\not\equiv$	Non-identity of objects or types; stronger and different from numerical inequality $\neq$.
$\not\Rightarrow$	Non-entailment: the antecedent does not by itself justify or imply the consequent.
$\iff$, $\implies$	Definition or stated equivalence, and implication, respectively. Their status is governed by the surrounding definition, axiom, principle, proposition, or application bridge.
$\mathrm{Type}(\cdot)$	Type-classification operator used to prevent category transfer among bearers, stages, records, models, and temporal denotation.
$\top, \bot$	Truth values of a declared proposition or typed relation.
$\dashrightarrow$	Partial map: the map need not be defined on every member of its source domain.
$\exists!$	Unique existence.
$\mathbf{1}[\cdot]$	Indicator of the enclosed proposition in predictive target definitions.
Recurrent named predicates and application labels	
ActuallyRealizedBearer ValidBearerAttribution	Respectively classification of an actually realized bearer and validity of assigning a record, state, or occurrence to the declared bearer.
RelevantPhysicalFactor PartOf	Context-relative relevance of a physical factor, and a declared part–whole relation among bearers or bearer components.
SameRealizationContent LocalizedRealization	Criterion-relative sameness of selected realization content, and localization of a declared bearer realization under the stated model or attribution conditions.

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Symbol or notation	Meaning and governing scope
IdentityEndingOf ConstituentReplacement DistributedBearer	Application classifications for identity-ending attribution, replacement of constituents without automatic identity transfer, and bearers spatially distributed across components or regions.
DefinitionOfTime DifferentTimes DifferentCosmicTimes	Metalinguistic or type-boundary labels used to deny that differing physical descriptions, rates, records, or locations establish multiple times or cosmic extensions.
Rate RateOfTime RateOfTimeFor	A declared physical or model rate and the rejected transfer of such a rate to time itself or to bearer-specific private times.
ClockOutput ClockRate ClockFailure	Physical output, model- or protocol-relative clock rate, and failure classification of a clock bearer. None is a property or deformation of ITOF time.
LocalClockLabel LocalDate CalendarDate IlluminationState	Local operational or civil labels and a local illumination classification; they organize physical records and cycles without defining cosmic-stage identity.
SpatiallySeparated Stable CompletePhysicalStasis	Spatial separation, criterion-relative stability, and the stronger claim of complete physical stasis. The first two do not entail the third.
FirstDetectionAt FirstAcceptedRecordAt	Protocol- and model-relative first accepted detection and first accepted record assignments; neither defines the ontic formation boundary.
CommonCosmicStage ProperTimeFunctional	Type labels for an actual common cosmic stage and a relativistic worldline functional; they belong to different types.
Occurrence RecordRealization Reading Claim	Successive physical and inferential roles in the evidential chain. No adjacent or nonadjacent pair is an identity relation.
RecordOf RemoteRecordOf	Protocol/model-conditioned relations connecting a physical record to a source occurrence, locally or remotely; the record is not the occurrence, source state, or stage.
RadiativeCarrier Emission ArrivalAt DetectorInteraction	Physical roles in a remote source–record chain. A carrier or signal does not transport time or an earlier cosmic stage.
ValidExplanatoryModel ExplanatoryWarrant	Schematic epistemic labels for an accepted explanatory model and the resulting history-conditioned explanatory warrant; they are not ontological primitives.
Predicted OutcomeAttainedBy PredictionStudyAdmissible	Prediction, warranted attainment by a declared cutoff, and admissibility of a prospective prediction study. Prediction does not actualize its target.
Score	Predeclared performance functional used in predictive comparisons; its direction and evaluation set are fixed by the study design.

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Symbol or notation	Meaning and governing scope
AdmissibleStudy ObservedDifference OperationalStasis	Study-admissibility, accepted operational difference, and no-difference classification under valid planned comparisons. Operational stasis is not complete physical stasis.
Decision DecisionRule StudyConclusion	Preregistered decision status, rule, and restricted study conclusion, with outcomes such as support, adverse, or inconclusive.
AcceptedBearerRecord SameBearerRecords PositiveWitness RestrictedEmpiricalWitness	Accepted bearer-attributed records, a valid same-bearer record pair, a criterion-relative positive witness, and a bounded empirical witness.
StagewiseExhaustiveTest ExactCosmicStageIdentified	Stronger targets not entailed by a finite restricted witness: exhaustive inspection of all applicable stages and exact identification of one cosmic stage.
AdverseAdmissible BearerCompleteStasisWarrant NontrivialHistoryWarrant Reject_{Π}	Admissibility of an adverse result, strengthened warrant for bearer-complete stasis, warrant for a nontrivial represented history, and a revisable scientific rejection decision under protocol family Π.
ModelBoundedCalculationalAdequacy	Calculational adequacy restricted to declared models, data, protocols, variables, and tolerance; it does not transfer temporal identity.
IllTyped Curved	Type-error judgment and a geometrical curvature predicate. Curvature may be assigned to appropriate geometric objects, not to T_{ITOF}.
Cosmic domain, universal succession, and time	
$\mathcal{S}_C$	Complete extensional domain of actual common cosmic stages in the complete actual cosmic history.
$\prec_C$	One fixed, irreversible, strict total earlier–later ordering on $\mathcal{S}_C$.
$\preceq_C$	Non-strict cosmic ordering: equality or $\prec_C$, where introduced.
$s^0_{\mathrm{C}} = s^0_C$	Unique actual least common cosmic stage supplied by the Cosmic Origin Postulate.
$\mathcal{S}_C^{\leq a}$	Stage-relative attained prefix: stages equal to or earlier than reference stage a.
$\mathrm{AttainedBy}(s; a)$	Stage s belongs to the attained cosmic prefix no later than a.
$T_{\mathrm{ITOF}} = (\mathcal{S}_C, \prec_C)$	Canonical ITOF denotation of time: the universal ordering and succession of common cosmic stages in one common cosmic extension.
$\mathcal{U}_{\mathrm{phys}}$	Complete domain of actually realized physical bearers across the complete actual cosmic history.
$\mathcal{S}_{\mathrm{phys}}(s)$	Population of physical bearers whose numerical identities are realized at common cosmic stage s.
CSP	Cosmic Stage Population commitment: every actual common cosmic stage has a nonempty physical-bearer population.
NCEC	Nontrivial Cosmic Extension Condition: at least one actual stage is later than s^0_{C}; it adds no metric, density, or greatest-stage claim.
$\mathrm{Later}_{\mathrm{C}}(s)$	Stage s is later than at least one member of the common cosmic-stage domain.

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Symbol or notation	Meaning and governing scope
$\mathrm{Greatest}_{\mathrm{C}}(g)$	Order-theoretic predicate that $g \in \mathcal{S}_C$ has no later cosmic stage; its existence is not postulated.
$\mathrm{TerminalUniverse}(s)$	Conditional universal terminal-ending predicate: greatest stage, ending of every bearer present there, and no bearer formation there.
Physical bearers, identity, and realization	
$\mathrm{PhysicalSystem}(A)$	Bearer A satisfies the framework's physical-system criterion.
$\mathrm{StudyQualified}_{P,M}(A)$	Bearer A is qualified for study under protocol P and model M; study qualification is narrower than physical actuality.
$\mathrm{ExistsAs}(A, s)$	The numerical identity of bearer A is physically realized at common cosmic stage s.
$\mathrm{Present}_{\mathrm{C}}(A; s)$	Bearer A is present at common cosmic stage s.
$\mathrm{CoPresent}_{\mathrm{C}}(A, B; s)$	Bearers A and B are present at the same common cosmic stage s; no instantaneous causal channel follows.
I_A	Identity domain of bearer A: the common cosmic stages at which A exists as that numerical bearer.
X_A	Bearer-specific state, observable, or physical-description map over I_A.
$\mathcal{H}_A = (I_A, \prec_C \|_{I_A}, X_A)$	Complete identity-bounded physical history of bearer A.
IDC	Identity-Domain Convexity principle: if the same bearer identity occurs at two bounding stages, it occurs at every common stage ordered between them.
$\mathrm{IdCont}_A(r, s)$	Declared continuity of the same numerical bearer identity A between stages r and s.
$\mathrm{PhysReal}^+_A(s)$	Bearer-specific positive physical realization of A at s. The superscript $+$ is classificatory, not a numerical magnitude.
CMA, $\mathrm{CMA}(s)$	Cosmic Moment Axiom and its stage-indexed form: every bearer in $\mathcal{S}_{\mathrm{phys}}(s)$ is present and undergoes its own positive physical realization.
$\mathrm{UCC}(A)$, $\mathrm{UCC}(A, s)$	Universal Change Continuity for bearer A, and its stage-indexed bearer instance, derived from CMA over later history members.
$\mathrm{UCC}^+(A)$	Non-vacuous UCC classification requiring both $\mathrm{UCC}(A)$ and a nontrivial bearer history.
$\mathrm{NontrivialHistory}(A)$	Bearer history I_A contains at least two ordered members.
$\mathrm{LaterInHistory}_A(s)$	Stage $s \in I_A$ has an earlier member in the same bearer history.
$\mathrm{LaterReal}_A(s)$	Later-history positive realization: $\mathrm{LaterInHistory}_A(s)$ together with $\mathrm{PhysReal}^+_A(s)$.
$\mathrm{FurtherReal}_A(r, s)$	Ordered positive realizations of the same bearer at $r \prec_C s$.
$\mathrm{FunctionalFailure}_{A,\kappa}(s)$	Failure of bearer A relative to declared functional criterion κ; it does not by itself establish identity ending.
Formation, ending, transformation, and successor relations	
f_A, e_A	Unique formation and ending members of the complete identity history of bearer A.
$\mathrm{IdentityFormationRealized}_A(f)$	Stage-resolved physical occurrence through which the identity of bearer A first becomes actual.
$\mathrm{AttainedFormation}_A(f)$	Ontic formation-boundary predicate: formation realization at $f \in I_A$ with no earlier member of I_A.
$\mathrm{FormationReal}_A(f)$	Derived identity-forming positive-realization classification.

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Symbol or notation	Meaning and governing scope
$\mathrm{EstimatedFormationWindow}_{P,M}(A, W)$	Protocol- and model-relative formation estimate W. Only the estimate together with its separate warrant implies $f_A \in W$; it does not multiply ontic beginnings.
$\mathrm{End}_A(e)$	Ontic identity-ending predicate for bearer A at its unique ending member e.
$\mathrm{IdentityEndingRealized}_A(e)$	Stage-resolved physical realization through which the identity of A ceases under its declared identity criterion.
$\mathrm{EndingReal}_A(e)$	Derived identity-ending positive-realization classification.
$\mathrm{EstimatedTerminationWindow}_{P,M}(A, W \mid a)$	Protocol- and model-relative ending estimate. Together with attained completion and its separate warrant, it implies $e_A \in W \subseteq \mathcal{S}_C^{\leq a}$.
$\mathrm{HistoryComplete}(A)$	The complete identity history of A contains an ending member.
$\mathrm{CompletedBy}(A; a)$	The ending of A has been attained no later than reference stage a.
$\mathcal{P}, \mathcal{Q}, \mathcal{E}$	Respectively predecessor set, successor set, and declared production-incidence relation in a transformation specification.
$\Lambda_{\mathrm{prod}} = \Lambda_{\mathrm{prod}}$	Typed domain of admissible production specifications $\langle e, \mathcal{P}, \mathcal{Q}, \mathcal{E}\rangle$.
$\mathrm{PhysicalOriginLink}(\mathcal{P}, B; s)$	Primitive ontic physical-origin relation from declared contributors $\mathcal{P}$ to newly formed bearer B at s.
$\mathrm{OriginatesAt}(B, \mathcal{P}, s)$	Derived origin classification combining formation of B at s with a declared physical-origin link.
$\mathrm{OriginWarrant}_{P,M}[\cdot]$	Protocol- and model-relative scientific warrant for a declared physical-origin attribution.
$\mathrm{TransformAt}^{\mathrm{ont}}(\mathcal{P}, e, \mathcal{Q}; \mathcal{E})$	Ontic same-stage identity-producing transformation from predecessor set $\mathcal{P}$ to successor set $\mathcal{Q}$ with incidence relation $\mathcal{E}$.
$\mathrm{TransformWarrant}_{P,M}[\cdot]$	Scientific warrant for asserting a specified ontic transformation; it is not part of the ontic relation.
$\mathrm{PhysicalProductionLink}(A, B; e)$	Physical production link from predecessor A to newly formed bearer B at stage e.
$\mathrm{DirectOutput}(A, B; \mathcal{P}, e, \mathcal{Q}, \mathcal{E})$	One declared direct production incidence inside an ontic transformation specification.
$\mathrm{SuccAt}(A, B; e)$	Direct successorship of B from A at stage e.
$\mathrm{Succ}(A, B)$	Stage-unspecified direct successorship: there exists a stage e with $\mathrm{SuccAt}(A, B; e)$.
$\mathrm{Succ}^+(A, B)$	Positive finite successor closure: one or more direct successor edges connect A to B.
$\mathrm{IndSucc}(A, B)$	Strict indirect successorship requiring at least two direct successor edges.
$\mathrm{ContinuesAfter}(A, s)$	Bearer A exists at s and at some later member of its own identity domain.
$\mathrm{SuccessorProducingEnd}_A(e)$	Ending of A at e that directly produces at least one successor identity.
$\mathrm{PhysicalOutcomeLink}(A, e, B)$	Primitive ontic contribution from A at e to recipient bearer B; ending and recipient-continuity conditions are supplied separately.
$\mathrm{ExtantOutcomeContinuation}_A(e)$	Ending of A whose physical outcome contributes to an already existing distinct bearer that continues after e.
NoInfiniteSameStageCascade	Governing model-coherence constraint excluding an infinite successor sequence of one-stage bearers formed and ended at one common stage.

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Symbol or notation	Meaning and governing scope
Spatial realization and motion	
R	Declared physical reference bearer for a spatial attribution; R remains a bearer under CMA.
$\Xi_{A\|R} : I_A \cap I_R \to \Omega^{\mathrm{sp}}_{A\|R}$	Ontic spatial-configuration map of bearer A relative to reference bearer R.
Σ, $\rho^{\mathrm{sp}}_{A\|R,\Sigma}$	Declared spatial representation scheme and its partial map from ontic spatial configurations to a representation codomain.
$\Lambda_{R,\Sigma}$	Spatial-description codomain associated with reference bearer R and representation scheme Σ.
$\ell_{A\|R,\Sigma}(s)$	Represented spatial attribution obtained from $\Xi_{A\|R}(s)$ under scheme Σ; it is not the ontic configuration itself.
$\mathrm{Occupies}^{\kappa_{\mathrm{occ}}}_{R,\Sigma}(A, L; s)$	Typed occupancy relation under declared occupancy criterion κ_{occ}.
$\Gamma^{\mathrm{sp}}_{A\|R}$	Declared criterion for comparing spatial configurations of A relative to R.
$\mathrm{NetSpatialDifference}_{A\|R,\Gamma^{\mathrm{sp}}}(r, s)$	Criterion-relative non-equivalence of the same bearer's spatial configurations at ordered stages $r \prec_C s$.
$\mathrm{MotionOver}_{A\|R,\Gamma^{\mathrm{sp}}}(J)$	Existence of a net spatial-difference witness within nonempty investigation domain J.
$\mathrm{Rest}_{A\|R,\Gamma^{\mathrm{sp}}}(J)$	Criterion-relative stability of the declared spatial relation over J; it does not entail complete physical stasis.
$\Xi_{A\|R}\|_J$, $\widehat{\gamma}_{A\|R;P,M}$	Ontic spatial path restricted to J, and a protocol/model-conditioned reconstructed path; the two are not identical.
$\boldsymbol{x}_{A\|R}, \boldsymbol{v}_{A\|R}, \lambda$	Model position, model velocity, and declared path or record parameter. They do not define a rate or magnitude of ITOF time.
Clocks, records, observation, and remote access	
$\mathrm{Clock}(C)$	Bearer C is selected as a physical clock; every clock remains a physical system with its own history.
$\mathcal{R}_{C,P}$	Clock record-production map from a physical clock-history segment and protocol settings to a clock-record domain.
$\mathfrak{H}^{\mathrm{phys}}_{C,J}, \Theta_{C,P}, \mathfrak{R}_{C,P}$	Physical clock-history segment domain, protocol-setting domain, and clock-record codomain.
$N_{C,P} : \mathfrak{R}_{C,P} \to \mathbb{R}_P$	Clock reading map under protocol P; its numerical output is not ITOF time or a cosmic stage.
$\triangleleft_P$	Protocol-relative operational order on records; it is not identical with $\prec_C$.
$\Delta N_{C,P}$	Difference between two numerical clock readings under the declared protocol.
$\mathrm{Sync}_{F,P}(r_1, r_2)$	Synchronization classification of two records under convention or frame F and protocol P.
$\rightsquigarrow_{\mathrm{phys}}$	Declared physical-production or physical-access arrow in occurrence–record chains; it is not an identity relation.
$\mathrm{RecordRealizedAt}_C(r_C, s)$	Clock or record bearer C realizes record r_C at actual common cosmic stage s.
$\mathrm{RecordState}_{B_R}(q; s)$	Physical record state q of record bearer B_R at stage s.
$\mathrm{Detected}_{P,M,\varepsilon}(A, s)$	Detection of bearer or manifestation under protocol P, model M, and declared threshold or sensitivity ε.
$\mathrm{CandidateStages}^{A,\chi}_{P,M}(r)$	Model-conditioned set of candidate cosmic stages associated with record r, bearer A, and target occurrence χ.

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Symbol or notation	Meaning and governing scope
$\mathrm{RecordStageCandidate}_{A,\mathcal{X};P,M}(r,s)$	Typed membership of stage s in the candidate-stage set generated from record r; it is not an occurrence warrant.
$\mathrm{Warrant}_{P,M}[\mathcal{C}]$	Protocol- and model-relative scientific warrant for typed claim $\mathcal{C}$; warrant neither creates nor enters the ontic relation asserted.
$\mathrm{WarrantedUniqueStageAssignment}_{P,M}(\mathcal{C})$	Warrant that a fully typed claim $\mathcal{C}$ identifies one exact common cosmic stage.
$\mathcal{L}_P^{\mathrm{core}}, \mathcal{L}_P$	Core measurement-bearer family and the enlarged measurement-system family under protocol P.
$\mathcal{N}_P(s), \mathcal{F}_P(s)$	Measurement influence network and relevant physical-factor family at stage s.
s_S, s_E, s_A, s_D, s_R	Source-realization, emission, arrival, detector-interaction, and record-realization stages in a declared remote record chain.
$\mathrm{ValidRemoteOrderBridge}_{S;P,M}(q_1,q_2;e_1,e_2)$	Validated bridge from record order to source-occurrence order, accounting for propagation, processing, and provenance.
$E_i^{(P,M)}, \Pi_i^{(P,M)}, R_i^{(P,M)}$	Modelled emission, propagation, and reception assignments for remote record i, with $R_i = E_i + \Pi_i$.
$\Delta E, \Delta\Pi, \Delta R$	Differences of the declared emission, propagation, and reception assignments; reception separation need not equal source separation.
$\widehat{I}_{S;P,M}, J$	Reconstructed source window and declared record or investigation domain in the restricted remote-continuity application.
$\mathrm{UCC}^{\mathrm{emp}}_{S;P,M}(\widehat{I}, J)$	Restricted epistemic continuity conclusion requiring a remote change witness, adequate continuity coverage, and an accepted continuity model.
Historical reconstruction, prediction, and empirical testing	
$I_A^{\le s}, \mathcal{H}_A^{\le s}$	Ontic identity-domain prefix and ontic physical-history prefix of bearer A no later than stage s.
$\widehat{\mathcal{H}}^{\le u}_{A;P,M}$	Protocol/model-conditioned reconstructed history prefix; it is not the complete ontic history prefix.
$\widehat{\mathcal{G}}_{A;P,M}(u)$	Reconstructed current configuration at reference index or stage proxy u.
$J_A^+(s_\star), \widehat{J}^+_{A;P,M}(u)$	Ontic later-stage target set and protocol/model future evaluation window; prediction does not attain either target.
$Y^{J^+}_{\mathrm{fail}}, Y^{J^+}_{\mathrm{end}}, Y^{J^+}_{\mathrm{succ}}$	Criterion-relative predictive indicator targets for functional failure, identity ending, and declared successor formation.
$D(P), \mathfrak{R}_P$	Measurement or study channel selected by protocol P, and its typed record domain.
$\mathbf{P} = (P_d)_{d\in\mathcal{D}_P}$	Declared multichannel protocol family indexed by covered domains or channels d.
$\mathcal{I}_P, \mathcal{J}_P$	Protocol index domain and preregistered planned comparison-pair set.
$\iota_P : \mathfrak{R}_P \dashrightarrow \mathcal{I}_P$	Partial map assigning accepted records to protocol indices.
$H^{\mathrm{OpNS}}_{A;P,M,V,\varepsilon,\mathcal{J}_P}$	Restricted operational non-stasis hypothesis; it is not identical with unrestricted ontological UCC.
$\mathcal{E}_{A;P,M,V}$	Accepted evidence set for bearer A, protocol P, model M, and represented variable family V.
$\mathfrak{P}^{\mathrm{acc}\mid\mathrm{plan}}$	Accepted planned-comparison set; an empty set yields an inconclusive decision rather than support or rejection.

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Symbol or notation	Meaning and governing scope
$\Delta_{D;P,M}$	Protocol/model-relative nonnegative scalar discrepancy functional on a declared common comparison codomain; it is not assumed to be a metric.
$\mathfrak{O}_{D;P}$	Common comparison codomain for accepted predicted and observed outputs in empirical domain D.
$\varepsilon^{\mathrm{acc}}_{D;P,M} \in \mathbb{R}_{\geq 0}$	Prospectively declared nonnegative acceptance tolerance for the quantitative comparison.
Relativistic-model notation retained under the ITOF type boundary	
$\mathcal{Q}_{\mathrm{rel}} = \bigsqcup_{\tau \in \mathfrak{T}_{\mathrm{rel}}} \mathcal{Q}^{(\tau)}_{\mathrm{rel}}$	Disjoint typed family of relativistic quantities. Its members are external model objects and are not ITOF time.
$x^{\mu}_{F}(e)$, Λ	Coordinate assignment to represented occurrence e in frame F, and a Lorentz coordinate transformation between frames.
$g_{\mu\nu}, ds^2$	Lorentzian metric and metric interval of the declared relativistic model; neither is T_{ITOF}.
$\tau[\gamma, g]$	Proper-time functional of worldline γ and metric g; it is not a bearer-specific portion or deformation of ITOF time.
$e_1 \sim_F e_2$	Coordinate simultaneity under frame F; it is distinct from independently warranted common-stage participation.

1. Foundational Position, Reconstruction Method, and Governing Status

1.1 Purpose and scope

V29/F9 is the sequential historical-critical successor to V28/F8. It preserves the validated reconstruction of cosmic origin, common cosmic stages, bearer-specific realization, identity-bounded histories, transformation, outcome, successor attribution, evidential restraint, and the rejection of relativistic temporal ontology. Its additional purpose is to integrate these commitments with spatial realization, place, motion, local physical cycles, clocks, remote records, historical reconstruction, prediction, and cross-domain application.

The term *comprehensive* is conditional and type-based. V29/F9 does not enumerate every physical bearer, mechanism, or future classification. Its definitions and relations apply wherever their stated bearer, identity, domain, and warrant conditions are satisfied. Applications test scope and category discipline; they do not generate the foundational ontology.

1.2 Sequential reconstruction and source order

Earlier versions are developmental records rather than simultaneously governing propositions. For every retained element q,

$$\text{Retained}_{V28\to V29}(q) \Longrightarrow \text{Revalidated}_{V29}(q). \tag{1}$$

Revalidation may retain, relocate, clarify, reconstruct, or exclude an earlier formulation. Authorial intention identifies the concept under examination but does not by itself establish logical coherence, physical truth, or scientific warrant. The direct baseline is final V28/F8; authorial discussion clarifies intended distinctions; V27/F7 and earlier versions supply historical comparison; new applications test scope rather than confer foundational authority. The documented developmental sequence used for this reconstruction is represented by V23/F3 through V28/F8 [6, 5, 4, 3, 2, 1].

Formal and equation discipline

Every central statement is classified as a definition, primitive ontological predicate, domain or application condition, postulate, axiom, principle, model constraint, derived proposition, application-specific bridge, or epistemic warrant. A displayed equation is admitted only where it fixes a type, domain, dependency, constraint, or testable inferential relation more precisely than prose. Repetition, notation alone, or prior use does not justify equation status.

Definitions do not cause the facts they classify. Ontic propositions and epistemic warrants remain distinct. Model quantities do not acquire ontological identity through predictive success, and application bridges do not redefine the foundational predicates they apply.

Governing status

V29/F9 is intended as the long-term governing foundational reference of ITOF. Later works may apply, quantify, test, or clarify the framework without replacing it. A new foundational version is warranted only by a substantial new foundational issue, an internal contradiction, a type or dependency failure, or a decisive physical challenge requiring reconstruction. This status is methodological rather than a claim of infallibility or permanent finality.

2. The Universe, Cosmic Origin, and the Complete Cosmic Domain

2.1 The governing meaning of the universe

V29/F9 uses the term *universe* to denote the totality of all actually realized physical systems without exception.

Let

$$\mathcal{U}_{\text{phys}} := \{A \mid \text{PhysicalSystem}(A)\} \tag{2}$$

denote the complete domain of actually realized physical bearers across the complete actual cosmic history. The detailed bearer criterion is developed in Section 3; the present definition fixes only the governing domain required for the meaning of the universe.

Define

$$\text{Universe} := \text{TotalityOfAllPhysicalSystems} = \text{Totality}(\mathcal{U}_{\text{phys}}). \tag{3}$$

The universe is not introduced as an additional physical bearer standing above, outside, or alongside the systems that constitute it. The governing type distinction is

$$\begin{aligned} \text{Type}(\text{Universe}) &= \mathsf{PhysicalSystemTotality}, \\ \text{Type}(A) &= \mathsf{PhysicalBearer}, \qquad A \in \mathcal{U}_{\text{phys}}. \end{aligned} \tag{4}$$

Accordingly,

$$\text{Universe} \not\equiv A \qquad \text{for any } A \in \mathcal{U}_{\text{phys}}. \tag{5}$$

This statement does not deny the physical actuality of the universe. It prevents the totality of all systems from being duplicated as one additional bearer merely because it is named as a totality.

V29/F9 therefore assigns no independent identity domain, state map, or bearer history to an additional cosmic object:

$$\neg\,\text{AdditionalCosmicBearer}(\text{Universe}). \tag{6}$$

References to the physical history of the universe denote the plurality, ordering, interrelation, formation, persistence, and ending of physical systems within the common cosmic succession. They do not denote one independent bearer history of the form later assigned to an individual system.

2.2 Physical totality and scientific classification

Membership in $\mathcal{U}_{\text{phys}}$ is fixed by physical actuality rather than by present observation, naming, classification, or experimental access.

A system may belong to $\mathcal{U}_{\text{phys}}$ even when it is not presently detected or study-qualified. Therefore,

$$\text{StudyQualified}_{P,M}(A) \Longrightarrow \text{PhysicalSystem}(A), \tag{7}$$

whereas

$$\text{PhysicalSystem}(A) \not\Rightarrow \text{StudyQualified}_{P,M}(A). \tag{8}$$

The first implication states that a legitimately studied bearer must be a physical system. The nonconverse prevents limitations of current science from restricting the universal physical ontology.

No foundational quantifier over $\mathcal{U}_{\text{phys}}$ may therefore be silently replaced by a quantifier over presently observed, classified, or experimentally accessible systems.

2.3 The complete actual cosmic-stage domain

Let

$$\mathcal{S}_C \tag{9}$$

denote the complete extensional domain of common cosmic stages physically realized in the complete actual cosmic history.

Every member $s \in \mathcal{S}_C$ is an actual common cosmic stage. It is not a coordinate value, clock reading, record, bearer state, geometrical slice, signal, observation, or model parameter.

The governing type distinction is

$$\begin{aligned} \text{Type}(\mathcal{S}_C) &= \mathsf{ActualCommonCosmicStageDomain}, \\ \text{Type}(\mathcal{U}_{\text{phys}}) &= \mathsf{ActualPhysicalBearerDomain}. \end{aligned} \tag{10}$$

Hence,

$$\mathcal{S}_C \not\equiv \mathcal{U}_{\text{phys}}. \tag{11}$$

The first domain contains common cosmic stages. The second contains physical bearers whose identities are realized at members of the first. Neither domain is generated by the other through definition.

The phrase *complete actual cosmic history* fixes the scope of theory-level quantification. It does not assert that all stages are simultaneously attained, that later stages are already physically present at earlier stages, or that the cosmic extension is a pre-existing container.

2.4 Bearer population at a common cosmic stage

Introduce the stage-indexed bearer population by

$$\mathcal{S}_{\text{phys}}(s) := \{A \in \mathcal{U}_{\text{phys}} \mid \text{ExistsAs}(A, s)\}, \qquad s \in \mathcal{S}_C. \tag{12}$$

Here $\text{ExistsAs}(A, s)$ states that the numerical identity of bearer A is physically realized at common cosmic stage s. Its full identity-domain role is developed later.

The set $\mathcal{S}_{\text{phys}}(s)$ contains bearers, not states, records, locations, or changes. A bearer's inclusion in that set states stage-indexed physical identity realization. It does not by itself define the content, magnitude, mechanism, or observability of the bearer's physical realization.

2.5 The actual first cosmic stage

Postulate 2.1 (Cosmic Origin Postulate)**.** The complete cosmic-stage domain has one actual least member s^0_{C}:

$$\boxed{s^0_{\mathrm{C}} \in \mathcal{S}_C, \qquad \neg\exists r \in \mathcal{S}_C\big(r \prec_C s^0_{\mathrm{C}}\big)}. \tag{13}$$

Because $\prec_C$ is total on distinct members of $\mathcal{S}_C$, the least-member condition yields

$$\forall s \in \mathcal{S}_C, \qquad s = s^0_{\mathrm{C}} \vee s^0_{\mathrm{C}} \prec_C s. \tag{14}$$

The Cosmic Origin Postulate identifies the unique least actual stage. It does not by itself establish that the stage is populated. Once the Cosmic-Stage Population Condition is adopted in Principle 5.1, its application at s^0_{C} yields $\mathcal{S}_{\text{phys}}(s^0_{\mathrm{C}}) \neq \varnothing$. This forward reference preserves the dependency order: cosmic origin supplies leastness, while CSP supplies population.

The Cosmic Origin Postulate does not introduce a cosmic bearer that forms at s^0_{C}. It states only that the common cosmic succession has an actual first member; bearer population and bearer-specific realization are supplied by their separately stated commitments.

Initial bearer formation

Let

$$\text{IdentityFormationRealized}_A(s)$$

denote provisionally the stage-resolved physical occurrence through which the identity of bearer A first becomes actual. Its governing boundary definition and uniqueness conditions are introduced only in Section 6.

No formation result is used as a premise in this section. After the Actual Formation Boundary Postulate is adopted, Equation (138) establishes that every bearer present at s^0_{C} has $f_A = s^0_{\mathrm{C}}$. That later result follows from the bearer-boundary commitment together with the leastness of the first cosmic stage; it is not derived from the time definition or from stage notation alone.

No empty or changeless preliminary stage

The first cosmic stage is not:

(i) an empty temporal location;
(ii) a changeless preliminary stage;
(iii) a container awaiting the later appearance of physical systems;
(iv) or a stage at which the universe exists before physical realization begins.

At s^0_{C}, CSP supplies nonempty physical population and CMA supplies bearer-specific positive physical realization for every bearer present there. After the Actual Formation Boundary

Postulate is introduced, the formation result in Equation (138) identifies s_{C}^{0} as the unique formation member of each initially present bearer.

The Cosmic Origin Postulate, CSP, CMA, and the Actual Formation Boundary Postulate therefore have distinct logical roles. None is derived from the definition of time or merely from the notation of another.

2.6 A nontrivial actual cosmic succession

The existence of one least member does not logically guarantee the existence of a later member. V29/F9 therefore adopts the independent nontrivial-extension condition

$$\boxed{\text{NCEC}: \quad \exists s \in \mathcal{S}_C \left(s_{\mathrm{C}}^{0} \prec_C s\right)}. \tag{15}$$

This condition states that the actual cosmic succession extends beyond cosmic origin.

It does not imply:

(a) discreteness or continuity;
(b) density or gaplessness;
(c) countability;
(d) equal spacing;
(e) metric duration;
(f) an immediate successor of s_{C}^{0};
(g) or a greatest cosmic stage.

2.7 The complete domain and the attained prefix

For every reference stage $a \in \mathcal{S}_C$, define the attained cosmic prefix by

$$\mathcal{S}_C^{\leq a} := \{s \in \mathcal{S}_C \mid s = a \vee s \prec_C a\}. \tag{16}$$

Define the stage-relative attainment predicate by

$$\text{AttainedBy}(s; a) \Longleftrightarrow s \in \mathcal{S}_C^{\leq a}. \tag{17}$$

The complete domain and the attained prefix have different scopes:

$$\begin{aligned} \mathcal{S}_C &: \text{ complete extensional actual cosmic domain,} \\ \mathcal{S}_C^{\leq a} &: \text{ stages attained no later than reference stage } a. \end{aligned} \tag{18}$$

If

$$a \prec_C v,$$

then

$$v \notin \mathcal{S}_C^{\leq a}, \qquad \neg\,\text{AttainedBy}(v; a). \tag{19}$$

Thus complete-domain quantification does not make a later stage attained at an earlier reference stage.

It does not turn the cosmic extension into a physically pre-existing container, and it does not convert knowledge of the complete history into simultaneous physical realization of all its members.

Prediction is not attainment

A model or protocol operating relative to reference stage a may predict, constrain, or assign a probability to a later candidate stage or physical outcome. Such a prediction is not the attainment of its target:

$$\mathrm{Predicted}_{P,M}(v \mid a) \not\Rightarrow \mathrm{AttainedBy}(v; a). \tag{20}$$

A predicted ending, formation, transformation, or successor relation remains model- and protocol-relative until the relevant physical boundary is attained and independently warranted.

Likewise, a later record may support reconstruction of an earlier physical occurrence without causing that occurrence or moving it to the stage at which the record is examined.

This distinction will govern later applications involving:

(i) archaeological remains and destroyed cities;
(ii) growth records preserved in trees;
(iii) genetic and lineage records;
(iv) geological and planetary records;
(v) and delayed stellar or galactic signals.

2.8 No postulated greatest cosmic stage

Define the order-theoretic greatest-stage predicate by

$$\mathrm{Greatest}_{\mathrm{C}}(g) \iff g \in \mathcal{S}_C \wedge \neg \exists u \in \mathcal{S}_C (g \prec_C u). \tag{21}$$

V29/F9 does not postulate that any $g \in \mathcal{S}_C$ satisfies this predicate.

This absence of a greatest-stage postulate is not a proof that a greatest stage is impossible. It preserves the distinction between:

(a) the actual first cosmic stage, which is adopted;
(b) and a possible final cosmic stage, whose realization remains conditional.

The complete definition of universal terminal ending is deferred to Section 9. That definition depends upon concepts not yet introduced here:

(i) identity ending;
(ii) the ending of every bearer then present;
(iii) absence of newly formed bearers;
(iv) physical-outcome closure;
(v) and absence of later cosmic stages.

Deferring the definition prevents ending predicates from being used before their bearer-relative meanings and dependencies have been fixed.

3. Physical Systems, Bearers, Factors, and Necessary Change

3.1 The governing physical-system predicate

The governing ontological predicate is

$$\text{PhysicalSystem}(A). \tag{22}$$

A physical system is an actually realized physical bearer distinguished by a domain-appropriate identity criterion and by the physical organization, constitution, relations, or characteristics through which that identity is realized.

The predicate does not denote merely:

(i) a possible object;
(ii) a class or linguistic name;
(iii) a selected property or observable;
(iv) a physical factor or influence;
(v) an interaction or mechanism;
(vi) a spatial location or region;
(vii) a record or model representation;
(viii) or an arbitrary collection lacking a justified bearer criterion.

Accordingly,

$$\text{PhysicalSystem}(A) \Longrightarrow \text{ActuallyRealizedBearer}(A). \tag{23}$$

The reverse implication is admissible only where the term ActuallyRealizedBearer is used with the same identity and physical-realization conditions. No circular proof of physical existence is intended.

3.2 Bearer identity and actual realization

For a declared physical bearer A, let

$$\text{ExistsAs}(A, s)$$

state that the numerical identity of A is physically realized at common cosmic stage s.

Its identity-realization domain is

$$I_A := \{s \in \mathcal{S}_C \mid \text{ExistsAs}(A, s)\}. \tag{24}$$

Because PhysicalSystem(A) denotes an actually realized bearer rather than a merely possible bearer type,

$$\text{PhysicalSystem}(A) \Longrightarrow I_A \neq \varnothing. \tag{25}$$

This implication is analytic relative to the declared meaning of PhysicalSystem. It does not physically produce the bearer or prove its existence from notation.

The complete treatment of the least member, persistence conditions, state map, physical history, and greatest member of I_A is deferred to Sections 6 and 7.

Physical existence and study qualification

Physical-system status is independent of present observability, classification, or experimental access.

The protocol- and model-relative predicate

$$\text{StudyQualified}_{P,M}(A)$$

states that A is adequately identified and accessible for a declared study under protocol P and model M.

The valid direction and its nonconverse were fixed in Equations (7) and (8).

A bearer may therefore be physically actual while remaining unknown, unclassified, inaccessible, or insufficiently resolved by available methods.

No universal ontological proposition in V29/F9 is restricted to study-qualified bearers. Study qualification restricts scientific assertion and experimental access, not physical actuality.

3.3 Bearers, properties, factors, and relations

A bearer may possess properties, realize states, participate in relations, undergo interactions, exchange physical quantities, and operate through mechanisms. These physically relevant items do not automatically become distinct physical systems.

Let

$$\text{RelevantPhysicalFactor}(F, A; s)$$

state that F is physically relevant to bearer A at stage s. Then

$$\text{RelevantPhysicalFactor}(F, A; s) \not\Rightarrow \text{PhysicalSystem}(F). \tag{26}$$

A physical factor may be:

(a) a bearer state or property;
(b) an internal organization or disposition;
(c) a relation between bearers;
(d) an exchange or boundary condition;
(e) a field or interaction as treated under the declared physical ontology;
(f) a constraint or environmental condition;
(g) or a mechanism borne by or realized among one or more systems.

By contrast, an influencing bearer is itself a physical system:

$$\text{InfluencingBearer}(B, A; s) \Longrightarrow \text{PhysicalSystem}(B). \tag{27}$$

The distinction prevents two opposite errors:

(i) reducing every influence or relation to an independent bearer;
(ii) and erasing an actual influencing bearer by describing it only as a factor.

A physical system may function as an influencing bearer in relation to another system while retaining its own identity and history.

3.4 The declared physical ground of bearer realization

For a bearer A at stage s, represent the high-level declared physical ground of its realization by the typed pair

$$\mathcal{G}_A(s) := (\mathcal{I}_A(s), \mathcal{E}_A(s)), \tag{28}$$

where:

(i) $\mathcal{I}_A(s)$ denotes declared internal physical factors, organization, states, or processes relevant to A;
(ii) $\mathcal{E}_A(s)$ denotes actual physical engagements, relations, exchanges, influences, and boundary conditions involving A and other physical systems.

The ordered pair preserves the analytical distinction between bearer-internal and relationally realized physical grounds. It does not assert that every physical mechanism possesses one unique or exhaustive decomposition into two independent classes.

The physical ground of realization belongs to actual systems and their physical relations. Neither time, the common cosmic stage, nor the earlier–later ordering is inserted into $\mathcal{G}_A(s)$ as a cause, energy source, force, mechanism, or influencing bearer.

3.5 Positive bearer-specific physical realization

The primitive ontological predicate

$$\text{PhysReal}_A^+(s) \tag{29}$$

states that a positive bearer-specific physical realization is actual in bearer A at common cosmic stage s.

Its governing signature is

$$\text{PhysReal}^+ : \mathcal{U}_{\text{phys}} \times \mathcal{S}_C \longrightarrow \{\top, \bot\}. \tag{30}$$

Positive physical realization is the general ITOF change genus. Its later classifications include:

(a) identity-forming physical realization;

(b) physical realization during continuing bearer identity;
(c) and identity-ending physical realization.

These classifications will be defined separately. The predicate $\mathrm{PhysReal}_A^+(s)$ does not by itself determine which subtype is realized, nor does it determine the magnitude, mechanism, distribution, rate, or observability of the occurrence.

The superscript + denotes positive physical realization. It is not a numerical subtraction sign, an assertion of macroscopic increase, or a comparison operator requiring an earlier state of the same bearer.

Existence does not define change

The predicates

$$\mathrm{ExistsAs}(A, s) \qquad \text{and} \qquad \mathrm{PhysReal}_A^+(s)$$

have different meanings.

The first states that the identity of A is physically realized at s. The second states positive bearer-specific physical realization in A at s.

Mere identity membership does not analytically entail change:

$$\mathrm{ExistsAs}(A, s) \not\Rightarrow \mathrm{PhysReal}_A^+(s). \tag{31}$$

The universal relation between stage-indexed bearer existence and positive physical realization is the independent physical commitment of the Cosmic Moment Axiom, introduced in Section 5.

This separation prevents V29/F9 from defining every existing system as changing and then presenting universal change as a derived discovery. The physical necessity claim is axiomatic, not a concealed consequence of the word *exists*.

3.6 Realization is not observation, detection, or record

Physical realization and epistemic access have different logical types.

For a detector, protocol, model, and threshold represented by P, M, ε,

$$\mathrm{PhysReal}_A^+(s) \not\Rightarrow \mathrm{Detected}_{P,M,\varepsilon}(A, s). \tag{32}$$

Likewise,

$$\neg\,\mathrm{Detected}_{P,M,\varepsilon}(A, s) \not\Rightarrow \neg\,\mathrm{PhysReal}_A^+(s). \tag{33}$$

Non-detection may result from limited sensitivity, sampling gaps, selected variables, noise, masking effects, inaccessible signal paths, model limitations, spatial restriction, or cumulative manifestation below a declared threshold.

However, non-detection does not license invention of one specified unobserved occurrence:

$$\neg\,\mathrm{Detected}_{P,M,\varepsilon}(A, s) \not\Rightarrow \mathrm{SpecifiedUnobservedRealization}_A(s). \tag{34}$$

The first boundary prevents absence of evidence from becoming evidence of complete physical absence. The second prevents an unrestricted appeal to hidden change from replacing domain-specific physical explanation.

3.7 Bearer specificity of realization

Physical realization belongs to the bearer in which it occurs.

For two bearers A and B at a common stage s,

$$\mathrm{PhysReal}_A^+(s) \wedge \mathrm{PhysReal}_B^+(s) \tag{35}$$

does not entail equality of:

(i) physical state;
(ii) realization content;
(iii) magnitude;
(iv) mechanism;
(v) spatial distribution;
(vi) rate;
(vii) functional consequence;
(viii) or observational accessibility.

Formally,

$$\begin{aligned} &\mathrm{PhysReal}_A^+(s) \wedge \mathrm{PhysReal}_B^+(s) \\ &\qquad \not\Rightarrow \mathrm{SameRealizationContent}(A, B; s) \wedge \mathrm{SameRealizationMechanism}_{A,B}(s). \end{aligned} \tag{36}$$

Cross-bearer comparison requires declared mappings into a common comparison domain. Truth of two realization predicates alone supplies no such map.

3.8 Local and partial realization

A physical alteration may be localized in one component, molecular site, cell, boundary region, relation, or substructure while the wider bearer identity persists.

Let

$$\mathrm{LocalizedRealization}(k, A; s)$$

state that a physical realization validly attributable to component or region k belongs to bearer A at stage s. Then

$$\begin{aligned} &\mathrm{LocalizedRealization}(k, A; s) \wedge \mathrm{ValidBearerAttribution}(k, A; s) \\ &\qquad \Longrightarrow \mathrm{PhysReal}_A^+(s). \end{aligned} \tag{37}$$

This is a sufficient attribution rule, not a claim that every bearer-level realization is spatially localized or reducible to one component.

The following inferences remain invalid without an independent identity bridge:

$$\text{MolecularChangeIn}(A; s) \not\Rightarrow \text{IdentityEndingOf}(A; s), \tag{38}$$

and

$$\text{SubsystemChange}(B, A; s) \not\Rightarrow \text{IdentityEndingOf}(A; s). \tag{39}$$

A local difference may warrant change in the containing bearer under a valid attribution criterion, while remaining insufficient to warrant termination of that bearer.

3.9 Simple and composite bearers

A physical bearer may be comparatively simple under one description or highly composite under another. Simplicity and complexity do not alter membership in the common cosmic succession.

For a composite bearer A, constituent persistence and composite persistence are distinct claims.

If p is a constituent of A, then

$$\text{PartOf}(p, A; r) \wedge \text{ExistsAs}(p, t) \wedge r \prec_C t \not\Rightarrow t \in I_A. \tag{40}$$

Continued existence of a constituent does not prove continued existence of the composite bearer.

Conversely,

$$\text{ConstituentReplacement}(A; r, t) \not\Rightarrow t \notin I_A. \tag{41}$$

Replacement, exchange, repair, or transformation of constituents does not by itself end the composite identity. The identity criterion for the composite must determine which constituent changes are compatible with persistence and which terminate the bearer.

3.10 Nested bearers

A physical system may be a part of another physical system while both retain justified bearer status under different identity criteria.

If

$$\text{PartOf}(B, A; s)$$

and both A and B satisfy their respective bearer criteria, then

$$\text{PhysicalSystem}(A) \wedge \text{PhysicalSystem}(B) \wedge A \neq B. \tag{42}$$

Their identity domains are independently defined subsets of the common cosmic domain:

$$I_A \subseteq \mathcal{S}_C, \qquad I_B \subseteq \mathcal{S}_C. \tag{43}$$

The histories of part and whole may overlap without being identical. A change or ending in B may contribute to change in A, but does not automatically determine the persistence or ending of A.

This scale discipline will govern molecular, genetic, cellular, organismal, ecological, mechanical, astronomical, and urban applications.

Open and exchanging systems

Exchange with an environment does not disqualify a physical bearer.

Living organisms, cells, clocks, machines, planets, stars, laboratories, and other systems may exchange matter, energy, radiation, momentum, signals, or constituents while their declared identities persist.

Therefore,

$$\mathrm{OpenSystem}(A) \nRightarrow \neg\, \mathrm{PhysicalSystem}(A). \tag{44}$$

An identity criterion for an open system must distinguish:

(a) exchanges compatible with persistence;
(b) reorganizations compatible with persistence;
(c) functional failures that do not terminate identity;
(d) and transformations that end the declared bearer.

No universal percentage of retained material, fixed constituent list, or absence of exchange defines identity persistence for every bearer class.

Distributed systems

A bearer may possess spatially separated components and still qualify as one distributed physical system under an independently justified identity criterion.

Let

$$\mathrm{DistributedBearer}(A)$$

state that the identity of A is realized through physically related components occupying spatially separated locations.

Then

$$\mathrm{DistributedBearer}(A) \nRightarrow \mathrm{MultiplePrivateTimes}(A). \tag{45}$$

Signal delay among components does not by itself divide the common cosmic stage. Whether the separated components constitute one bearer, several interacting bearers, or nested bearers remains an identity question governed by physical organization and domain evidence, not by instantaneous communication.

3.11 Places, regions, and bearers

A place, location, spatial region, distance, or direction does not become a physical system merely by being named or occupied.

The preliminary type boundary is

$$\text{SpatialDesignation}(L) \nRightarrow \text{PhysicalSystem}(L). \tag{46}$$

A place name may linguistically refer to:

(i) the location of one bearer;
(ii) a region occupied by many systems;
(iii) a composite physical system associated with that region;
(iv) or a changing collection of bearers conventionally grouped under one geographical name.

The referent must be declared.

A city may be treated as a complex physical bearer or system of systems under a justified identity criterion. The geographical location occupied by that city is not thereby identical to the city. Likewise, a galaxy is not identical to its abstract spatial designation, and a forest is not identical to the unqualified region in which its physical systems are realized.

The complete ontology of spatial realization is developed in Section 10.

3.12 No motion or machinery of cosmic stages

A common cosmic stage is not matter, energy, a field, a mechanism, a vehicle, or a moving carrier.

Physical systems do not move from one stage-object to another:

$$\neg\, \text{BearerTransportedByStage}(A, s). \tag{47}$$

A later stage is the common stage at which later physical realization is actual. The stage neither enters the bearer nor transports, produces, or accelerates its change.

Physical motion will later be defined as a change in spatial realization or spatial relation of a bearer under a declared reference. It will not be defined as movement through time or movement between temporal containers.

3.13 The status of necessary bearer-specific change

This section defines physical-system status and positive bearer-specific physical realization. It does not yet assert that every existing bearer has positive realization at every stage of its identity domain.

In particular,

$$\text{PhysicalSystem}(A) \wedge s \in I_A \nRightarrow_{\text{definition}} \text{PhysReal}_A^+(s). \tag{48}$$

The subscript on the non-entailment indicates that the implication does not follow from the definitions alone.

The universal necessity claim is introduced later through the Cosmic Moment Axiom:

$$\text{CMA}$$

and its bearer-relative consequence, Universal Change Continuity:

$$\mathrm{UCC}(A).$$

This dependency order is essential:

$$\begin{array}{ccc} \text{physical-system definition} & & \text{CMA} \\ \not\Longrightarrow & & \Longrightarrow \\ \text{universal physical change,} & & \text{stage-indexed bearer-specific realization.} \end{array} \tag{49}$$

The first relation prevents circularity. The second will be established only after the common cosmic stages, bearer population, and CMA have been defined.

4. Universal Cosmic Succession and the Denotation of Time

4.1 The canonical definition

Golden formulation: canonical definition of time

Definition 4.1 (Time)**. Time denotes the universal ordering and succession of common cosmic stages in one common cosmic extension.**

Formally,

$$\boxed{T_{\mathrm{ITOF}} = (\mathcal{S}_C, \prec_C)}. \tag{50}$$

Here:

(i) $\mathcal{S}_C$ is the complete extensional domain of common cosmic stages physically realized in the complete actual cosmic history;

(ii) $\prec_C$ is the one fixed and irreversible earlier–later ordering on that domain;

(iii) and the ordered domain constitutes the one common cosmic extension denoted by time.

The definition assigns no physical material, causal power, mechanism, motion, metric magnitude, or clock output to time.

The word *denotes* is governing. Time is not identified with the sentence that defines it, with a model used to represent it, or with a physical process used to organise records. The definition fixes the referent of the term *time* within ITOF.

4.2 The status of the temporal pair

The formal pair

$$(\mathcal{S}_C, \prec_C)$$

contains:

(a) one actual stage domain;

(b) and one earlier–later relation defined on that domain.

Its governing type is

$$\mathrm{Type}(T_{\mathrm{ITOF}}) = \mathsf{ITOFTemporalDenotation}. \tag{51}$$

This type is distinct from the bearer domain:

$$\mathrm{Type}(T_{\mathrm{ITOF}}) \neq \mathrm{Type}(\mathcal{U}_{\mathrm{phys}}). \tag{52}$$

It is also distinct from the type of an individual cosmic stage:

$$\mathrm{Type}(T_{\mathrm{ITOF}}) \neq \mathrm{Type}(s), \qquad s \in \mathcal{S}_C. \tag{53}$$

Time is therefore neither one physical system nor one cosmic stage. It denotes the universal ordering and succession of the complete common stage domain.

4.3 The earlier–later ordering

The relation

$$\prec_C \subseteq \mathcal{S}_C \times \mathcal{S}_C$$

is a strict ordering relation.

For all $r, s, u \in \mathcal{S}_C$, it satisfies irreflexivity:

$$\neg \left(s \prec_C s \right), \tag{54}$$

transitivity:

$$r \prec_C s \wedge s \prec_C u \Longrightarrow r \prec_C u, \tag{55}$$

and totality on distinct stages:

$$r \neq s \Longrightarrow \left(r \prec_C s \vee s \prec_C r \right). \tag{56}$$

Irreflexivity and transitivity yield asymmetry:

$$r \prec_C s \Longrightarrow \neg \left(s \prec_C r \right). \tag{57}$$

Accordingly, any two distinct common cosmic stages possess one fixed earlier–later relation.

The ordering does not require a physical signal, observer, clock, coordinate chart, or comparison protocol in order to be actual. Scientific knowledge of a particular order attribution may require records and inference, but epistemic access does not constitute the ontic relation.

4.4 Fixity and irreversibility

The ordering is fixed and irreversible.

Fixity means that if

$$r \prec_C s,$$

then r does not later become posterior to s, and s does not become anterior to r.

Formally,

$$r \prec_C s \Longrightarrow \neg\, \mathrm{OrderReversal}_C(r, s). \tag{58}$$

Irreversibility is not a force acting upon systems and is not a physical barrier preventing backward motion. It is the non-invertibility of the actual earlier–later ordering.

The statement

$$r \prec_C s$$

does not mean that r physically moves toward s, that s travels away from r, or that a substance flows between them. It states only their fixed order in the common cosmic succession.

Succession without stage motion

The term *succession* denotes the actual ordered realization of distinct common cosmic stages.

If

$$r \prec_C s,$$

then s is a later actual stage relative to r. This does not imply:

(i) that r transforms physically into s;
(ii) that s was contained inside r;
(iii) that one stage transports systems into another;
(iv) that a transition object moves between the two stages;
(v) or that the relation $\prec_C$ produces the later stage.

The governing non-entailment is

$$r \prec_C s \not\Rightarrow \mathrm{PhysicalTransformationOfStage}(r, s). \tag{59}$$

A later stage is a distinct member of the common ordered domain at which later physical realization is actual. The stage is not the physical change and does not move as the change occurs.

4.5 Ordering and succession are non-causal

The definition of time does not cause, produce, energise, accelerate, or regulate physical change.

Thus,

$$\text{TemporalOrder}(r, s) \nRightarrow \text{CausesPhysicalRealization}(r, s). \tag{60}$$

Conversely, physical change does not create the cosmic stages or their order:

$$\text{PhysicalRealization} \nRightarrow \text{Creates}\left(\mathcal{S}_C, \prec_C\right). \tag{61}$$

The relation between actual physical bearers and the common stages at which their identities are realized will be governed by bearer–stage membership and CMA. It is not contained inside the meaning of time.

Consequently,

$$\text{DefinitionOfTime} \nRightarrow \text{CMA}. \tag{62}$$

Likewise,

$$\text{CMA} \nRightarrow \text{DefinitionOfTime}. \tag{63}$$

The first non-entailment prevents the definition from proving a physical axiom. The second prevents the physical axiom from being used to create or redefine the cosmic ordering.

4.6 The common cosmic extension

The one common cosmic extension consists in the complete actual succession of common cosmic stages under $\prec_C$.

It is common because every physical bearer history is realized through membership in the same stage domain:

$$\forall A \in \mathcal{U}_{\text{phys}}, \qquad I_A \subseteq \mathcal{S}_C. \tag{64}$$

No physical system possesses a private cosmic-stage domain independent of $\mathcal{S}_C$.

Different bearers may possess:

(a) different formation stages;
(b) different identity-domain lengths;
(c) different physical states;
(d) different rates and mechanisms of change;
(e) different ending stages;
(f) and different records and observational accessibility.

None of those differences entails distinct times:

$$\mathcal{H}_A \neq \mathcal{H}_B \nRightarrow \text{DifferentTimes}(A, B). \tag{65}$$

The histories are different restrictions and contents within one common cosmic ordering.

4.7 No private system times

For a bearer A, the restriction

$$\prec_C |_{I_A}$$

orders the members of that bearer's identity history. It does not create an independent temporal relation ontologically detached from $\prec_C$.

Accordingly,

$$\text{BearerHistoryOrder}(A) = \prec_C |_{I_A}. \tag{66}$$

This is a restriction of the universal ordering, not a private time belonging to A.

The following inference is invalid:

$$I_A \neq I_B \not\Rightarrow \text{IndependentTemporalDomains}(A, B). \tag{67}$$

Two bearers may have different identity domains because they form and end at different stages. Where both exist at the same common stage, that stage is numerically the same member of $\mathcal{S}_C$ for both.

Their bearer-specific physical realizations remain distinct; their time does not.

The complete domain is not a pre-existing container

The complete-domain notation $\mathcal{S}_C$ was distinguished in Section 2 from the attained prefix $\mathcal{S}_C^{\leq a}$.

That distinction remains part of the time definition.

If

$$a \prec_C v,$$

then

$$v \notin \mathcal{S}_C^{\leq a}.$$

Therefore, theory-level quantification over the complete actual history does not imply that later stages are already physically attained at earlier stages.

The common cosmic extension is not:

(i) a container existing in advance of its actual stages;
(ii) a corridor through which systems travel;
(iii) a reservoir holding future events;
(iv) a material dimension occupied by physical bearers;
(v) or an independently acting entity.

The extension denotes the complete ordered succession itself.

No metric content in the time definition

The pair

$$T_{\mathrm{ITOF}} = (\mathcal{S}_C, \prec_C)$$

contains no metric function.

V29/F9 does not define a universal temporal distance

$$d_T : \mathcal{S}_C \times \mathcal{S}_C \longrightarrow \mathbb{R},$$

nor does it assume one.

Accordingly, from

$$r \prec_C s \prec_C u$$

one may infer order, but not:

(a) equal spacing;
(b) numerical duration;
(c) a ratio of temporal intervals;
(d) uniform stage separation;
(e) or a rate of passage of time.

The governing restraint is

$$r \prec_C s \not\Rightarrow \mathrm{MetricInterval}_T(r, s). \tag{68}$$

Measurements and model parameters may assign numerical values to physical processes, clock outputs, coordinate differences, propagation intervals, or reconstructed histories. Those quantities retain their own types and do not become the ontological time defined here.

No assumed stage spacing or local successor relation

The order conditions do not establish whether $\mathcal{S}_C$ is:

(i) discrete;
(ii) dense;
(iii) continuous;
(iv) gapless;
(v) countable;
(vi) finitely or infinitely extended;
(vii) or equipped with immediate successors.

In particular,

$$r \prec_C s \not\Rightarrow \mathrm{ImmediateSuccessorStage}(s, r). \tag{69}$$

The word *succession* in the definition does not assert that every stage has a uniquely identifiable immediate next stage. It denotes the actual ordered earlier–later extension without selecting one additional order topology.

The actual first member s_{C}^{0} is supplied by the Cosmic Origin Postulate. No greatest member is supplied by the time definition or by the strict total ordering alone.

What time does not denote

Within ITOF, time does not denote:

(i) matter;
(ii) energy;
(iii) a field;
(iv) a force;
(v) an interaction;
(vi) a physical factor;
(vii) a cause of change;
(viii) a coordinate;
(ix) a coordinate difference;
(x) a metric interval;
(xi) a proper-time functional;
(xii) a clock or clock output;
(xiii) a geometrical manifold or dimension;
(xiv) a moving carrier;
(xv) a spatial location;
(xvi) or an individual bearer history.

The central type boundary is

$$q \in \left\{ \begin{array}{c} \mathsf{Matter}, \mathsf{Energy}, \mathsf{Field}, \mathsf{Force}, \mathsf{Coordinate}, \mathsf{MetricInterval}, \\ \mathsf{ProperTimeFunctional}, \mathsf{ClockOutput}, \mathsf{SpatialLocation}, \mathsf{PhysicalBearer} \end{array} \right\} \Longrightarrow q \not\equiv T_{\mathrm{ITOF}}. \tag{70}$$

This equation states non-identity of types. It does not deny the physical existence, scientific usefulness, or calculational role of objects in the excluded classes.

Their physical and modelling roles will be examined under their proper types.

Time has no bearer-specific physical state

Because time is not a physical bearer, V29/F9 assigns it no:

(a) bearer identity;
(b) material composition;
(c) energy content;
(d) state map;
(e) mechanism;
(f) spatial location;

(g) velocity;
(h) acceleration;
(i) temperature;
(j) deformation;
(k) or physical history of the form $\mathcal{H}_A$.

Thus,

$$\neg\,\mathrm{PhysicalSystem}(T_{\mathrm{ITOF}}). \tag{71}$$

It follows that predicates whose valid domain is physical bearers may not be applied to time without a separately justified change of type.

This section does not yet develop the full confrontation with relativistic geometrical and operational predicates. That analysis is reserved for Section 17.

4.8 Physical rates belong to systems and models

A physical system may exhibit a rate of change in a selected quantity relative to a declared clock, record index, coordinate parameter, or model parameter.

Such a rate belongs to:

(i) the selected bearer quantity;
(ii) the comparison procedure;
(iii) the physical reference process;
(iv) and the model relating the records.

It does not establish a rate of time itself.

Formally,

$$\mathrm{RateOfPhysicalQuantity}_{A,P,M} \not\Rightarrow \mathrm{RateOfTime}\,. \tag{72}$$

Likewise, two systems may change at unequal rates under a declared comparison without possessing unequal times:

$$\mathrm{Rate}_{P,M}(A) \neq \mathrm{Rate}_{P,M}(B) \not\Rightarrow \mathrm{DifferentTimes}(A, B). \tag{73}$$

The content, magnitude, and rate of change remain bearer- and model-specific. The cosmic ordering remains one.

4.9 Recurrence does not identify cosmic stages

A physical system may later realize a state equivalent to an earlier state under a declared criterion.

For $r, s \in I_A$,

$$r \prec_C s \wedge X_A(r) \equiv_{\Gamma_A} X_A(s) \Longrightarrow r \neq s. \tag{74}$$

The equivalence of bearer states under Γ_A does not imply identity of the common cosmic stages:

$$X_A(r) \equiv_{\Gamma_A} X_A(s) \not\Rightarrow r = s. \tag{75}$$

Nor does recurrence reverse the order:

$$r \prec_C s \wedge X_A(r) \equiv_{\Gamma_A} X_A(s) \Longrightarrow \neg (s \prec_C r) . \tag{76}$$

A repeated illness, repeated orbital position, repeated clock display, repeated season, or repeated local lighting condition is a later physical realization that resembles an earlier one under a selected criterion. It is not a return to an earlier cosmic stage.

The detailed treatment of stability and recurrence is developed in Section 8.

Local physical differences do not multiply time

At one common cosmic stage, different physical systems and regions may realize different local conditions.

Examples include:

(a) night in one terrestrial region and day in another;
(b) different temperatures, pressures, or weather conditions;
(c) unequal clock readings;
(d) different calendar dates under local conventions;
(e) motion of one bearer and relative rest of another;
(f) and different stages of biological or stellar development.

These differences belong to physical systems, spatial relations, reference conventions, and records. They do not establish multiple times.

Schematically,

$$\mathrm{DifferentLocalPhysicalConditions}(A, B; s) \not\Rightarrow \mathrm{DifferentTimes}(A, B). \tag{77}$$

The detailed relations among place, motion, rotation, night and day, and local time conventions are reserved for Sections 10, 11, and 12.

Spatial extension and cosmic extension

The phrase *common cosmic extension* does not denote spatial size, distance, volume, or geometrical extension.

A spatial extension is a physical or model-relative spatial attribution to one or more bearers or regions. The common cosmic extension denotes the ordered succession of the common cosmic-stage domain.

Therefore,

$$\mathrm{SpatialExtension} \not\equiv \mathrm{CommonCosmicExtension} . \tag{78}$$

Distance may affect interaction, propagation, reception, and observational reconstruction. It does not create a separate cosmic ordering.

This type distinction will be developed fully after common-stage presence has been stated under CMA.

Clock and coordinate restraint

A clock is a physical system. A clock reading is a physical record or output generated through the clock's bearer-specific operation.

A coordinate is a model or representational assignment.

Neither is time:

$$\text{ClockOutput}_{C,P} \not\equiv T_{\text{ITOF}}, \qquad \text{CoordinateValue} \not\equiv T_{\text{ITOF}}. \tag{79}$$

Different clock outputs or coordinate assignments may be physically and scientifically significant. Their difference does not divide $\mathcal{S}_C$, produce private temporal domains, or deform the fixed ordering $\prec_C$.

The physical operation of clocks and the role of local conventions are developed later. The present subsection establishes only the governing type boundary required by the definition.

4.10 Definition, axiom, and empirical access remain distinct

The time definition is a semantic and ontological commitment. It is not an experimental record or an empirical decision rule.

Its status is:

$$\text{Status}\,(T_{\text{ITOF}} = (\mathcal{S}_C, \prec_C)) = \textsf{CanonicalDefinition}. \tag{80}$$

The properties of $\prec_C$ are governing order conditions. The existence of s^0_{C} is supplied by an independent postulate. CMA will be an independent physical axiom. Records and models provide epistemic access under separate bridges.

Accordingly, the following types remain distinct:

$$\begin{aligned} \textsf{CanonicalDefinition} &\neq \textsf{PhysicalAxiom}, \\ \textsf{PhysicalAxiom} &\neq \textsf{EmpiricalRecord}, \\ \textsf{EmpiricalRecord} &\neq \textsf{EpistemicWarrant}. \end{aligned} \tag{81}$$

No later section may use a record as the definition of time, use the time definition as empirical confirmation of CMA, or use CMA as the source of the ordering relation.

5. Common Cosmic Stages and the Cosmic Moment Axiom

5.1 The common cosmic stage

A common cosmic stage is one actual member

$$s \in \mathcal{S}_C$$

of the complete cosmic-stage domain.

Its commonness does not mean that all physical systems possess the same state, mechanism, magnitude of change, spatial position, or observable condition. It means that every bearer whose identity is physically realized at s is present at that numerically same common stage.

A common cosmic stage is not:

(i) a clock instant;
(ii) a coordinate hypersurface;
(iii) a physical signal;
(iv) a state of one privileged system;
(v) a spatial region;
(vi) a container holding physical bearers;
(vii) or an independently moving or acting entity.

The term *cosmic moment* in the name of the Cosmic Moment Axiom is used as a concise designation for a common cosmic stage. It does not introduce a metric instant, an infinitesimal duration, or a geometrical point of time.

5.2 Stage-indexed bearer population

For each $s \in \mathcal{S}_C$, the stage-indexed physical-system population was defined by

$$\mathcal{S}_{\text{phys}}(s) = \{A \in \mathcal{U}_{\text{phys}} \mid \text{ExistsAs}(A, s)\} = \{A \in \mathcal{U}_{\text{phys}} \mid s \in I_A\}\,. \tag{82}$$

The members of $\mathcal{S}_{\text{phys}}(s)$ are physical bearers whose numerical identities are realized at s.

The set does not contain:

(a) bearer states in place of bearers;
(b) physical changes in place of bearers;
(c) records in place of bearers;
(d) locations in place of bearers;
(e) or factors that lack independent bearer status.

Bearer membership at s does not by definition state the content or mechanism of physical realization. That content remains bearer-specific.

5.3 Common-stage presence

Define common-stage presence by

$$\text{Present}_{\text{C}}(A; s) \iff \text{PhysicalSystem}(A) \wedge s \in I_A. \tag{83}$$

Because

$$A \in \mathcal{S}_{\text{phys}}(s)$$

already means that $A \in \mathcal{U}_{\text{phys}}$ and $s \in I_A$, it follows that

$$A \in \mathcal{S}_{\text{phys}}(s) \iff \text{Present}_{\text{C}}(A; s). \tag{84}$$

The predicate $\text{Present}_{\text{C}}$ is nevertheless retained in the governing statement of CMA. Its function is semantic rather than additive: it makes explicit that the universal axiom concerns every bearer actually present at the same common cosmic stage.

It does not add a second membership condition and does not mean visual presence, detection, causal contact, or instantaneous communication.

5.4 The Cosmic-Stage Population Condition

Principle 5.1 (Cosmic-Stage Population Condition)**.** Every actual common cosmic stage is physically populated:

$$\boxed{\text{CSP}: \quad \forall s \in \mathcal{S}_C, \qquad \mathcal{S}_{\text{phys}}(s) \neq \varnothing}. \tag{85}$$

CSP classifies $\mathcal{S}_C$ as a domain of physically populated common cosmic stages. It excludes an actual stage containing no physical bearer.

CSP does not state that the bearers change. It asserts only that at least one physical-system identity is realized at every member of the actual cosmic-stage domain.

Thus,

$$\text{CSP} \not\Rightarrow \text{CMA}\,. \tag{86}$$

Conversely, because universal quantification over an empty $\mathcal{S}_{\text{phys}}(s)$ could be logically vacuous, CMA does not by itself supply stage population:

$$\text{CMA} \not\Rightarrow \text{CSP}\,. \tag{87}$$

The two commitments are therefore jointly governing but logically distinct.

5.5 Independence from cosmic origin and the time definition

The Cosmic Origin Postulate establishes one actual first stage s_{C}^{0}. CSP establishes physical population at every actual stage. The definition of time establishes the common ordered domain. None of these propositions independently establishes CMA.

The dependency boundaries are

$$\text{CosmicOriginPostulate} \not\Rightarrow \text{CMA}, \tag{88}$$

$$T_{\text{ITOF}} = (\mathcal{S}_C, \prec_C) \not\Rightarrow \text{CMA}, \tag{89}$$

The population–change non-entailment is already fixed by Equation (86).

The existence, order, population, and bearer-specific realization of a stage are related but non-identical commitments.

This separation prevents the following circular argument:

$$\text{systems are called changing} \Longrightarrow \text{all systems change.}$$

Positive physical realization was defined independently as a primitive ontological predicate. CMA now makes the universal physical assertion that it is actual for every present bearer at every actual common stage.

5.6 The governing axiom

Golden formulation: Cosmic Moment Axiom

Axiom 5.2 (Cosmic Moment Axiom)**.** At every actual common cosmic stage, every physical system whose identity is then realized is present at that same stage and undergoes its own bearer-specific positive physical realization:

$$\boxed{\mathrm{CMA}: \quad \forall s \in \mathcal{S}_C \; \forall A \in \mathcal{S}_{\mathrm{phys}}(s), \quad \mathrm{Present}_{\mathrm{C}}(A; s) \wedge \mathrm{PhysReal}_A^{+}(s)}. \tag{90}$$

The universal quantification is unrestricted across the physical population of every actual common cosmic stage.

It does not apply only to:

(i) presently observable systems;
(ii) macroscopic systems;
(iii) systems selected by a protocol;
(iv) systems undergoing visible or measurable alteration;
(v) systems interacting with an observer;
(vi) or systems classified by current science.

It applies to every $A \in \mathcal{S}_{\mathrm{phys}}(s)$, without exception.

5.7 The stage-indexed form

For one declared common cosmic stage, define

$$\mathrm{CMA}(s) \Longleftrightarrow s \in \mathcal{S}_C \wedge \forall A \in \mathcal{S}_{\mathrm{phys}}(s), \left[\mathrm{Present}_{\mathrm{C}}(A; s) \wedge \mathrm{PhysReal}_A^{+}(s)\right]. \tag{91}$$

The universal CMA statement is equivalent to

$$\mathrm{CMA} \Longleftrightarrow \forall s \in \mathcal{S}_C, \quad \mathrm{CMA}(s). \tag{92}$$

The stage-indexed form permits one stage to be examined without changing the universal scope of the axiom.

For any declared bearer A,

$$\mathrm{CMA}(s) \wedge A \in \mathcal{S}_{\mathrm{phys}}(s) \Longrightarrow \mathrm{Present}_{\mathrm{C}}(A; s) \wedge \mathrm{PhysReal}_{A}^{+}(s). \tag{93}$$

This is a derived bearer instance of CMA, not an additional axiom.

5.8 CMA at the first cosmic stage

CMA governs the actual first cosmic stage:

$$\mathrm{CMA}(s_{\mathrm{C}}^{0}). \tag{94}$$

Therefore,

$$\forall A \in \mathcal{S}_{\mathrm{phys}}(s_{\mathrm{C}}^{0}), \qquad \mathrm{Present}_{\mathrm{C}}(A; s_{\mathrm{C}}^{0}) \wedge \mathrm{PhysReal}_{A}^{+}(s_{\mathrm{C}}^{0}). \tag{95}$$

CMA establishes common-stage presence and positive physical realization at s_{C}^{0}; it does not independently establish the formation boundary. The formation result is introduced later by the Actual Formation Boundary Postulate and Equation (138). After that bearer-boundary commitment is in place, initial formation is classified as a subtype of positive bearer-specific physical realization without being used as a premise for CMA.

Positive realization at s_{C}^{0} does not require an earlier state of the same bearer. The superscript $+$ signifies positive physical realization at one bearer–stage pair, not a numerical difference from an earlier bearer state.

5.9 Global later stages and bearer-relative later history

Define a globally later cosmic stage by

$$\mathrm{Later}_{\mathrm{C}}(s) \Longleftrightarrow s \in \mathcal{S}_{C} \wedge s_{\mathrm{C}}^{0} \prec_{C} s. \tag{96}$$

Define bearer-relative later membership by

$$\mathrm{LaterInHistory}_{A}(s) \Longleftrightarrow s \in I_{A} \wedge \exists r \in I_{A}\, (r \prec_{C} s)\,. \tag{97}$$

The two predicates are not equivalent.

A stage may be globally later than cosmic origin while being the first identity member of a newly formed bearer. Therefore,

$$\mathrm{Later}_{\mathrm{C}}(s) \wedge A \in \mathcal{S}_{\mathrm{phys}}(s) \not\Rightarrow \mathrm{LaterInHistory}_{A}(s). \tag{98}$$

For example, a star, organism, instrument, city, or other composite system may first form at a globally late cosmic stage.

Conversely, bearer-relative later membership entails global laterness:

$$\mathrm{LaterInHistory}_{A}(s) \Longrightarrow \mathrm{Later}_{\mathrm{C}}(s). \tag{99}$$

The implication holds because an earlier bearer member must itself belong to $\mathcal{S}_C$, and no stage precedes s^0_{C}.

Neither predicate defines physical realization. CMA supplies positive physical realization wherever the bearer is present.

New formation and continuing identity at later stages

At a globally later common stage s, the population $\mathcal{S}_{\text{phys}}(s)$ may contain:

(a) bearers whose identities first form at s;
(b) bearers continuing from earlier members of their histories;
(c) and bearers whose identities end at s.

CMA applies to all of them.

For a newly formed bearer A,

$$\text{IdentityFormationRealized}_A(s)$$

classifies the boundary occurrence.

For a continuing bearer B,

$$\text{LaterInHistory}_B(s)$$

states that its identity has an earlier member.

For an ending bearer C, the ending classification will be supplied later.

The physical-realization predicate remains common in genus:

$$A \in \mathcal{S}_{\text{phys}}(s) \wedge \text{CMA}(s) \Longrightarrow \text{PhysReal}^+_A(s), \tag{100}$$

while the formation, continuing-history, and ending subtypes remain bearer-specific classifications. CMA does not collapse those distinctions.

5.10 Ordered positive realizations of one bearer

For $r, s \in I_A$, define the ordered positive-realization relation

$$\text{FurtherReal}_A(r, s) \Longleftrightarrow r, s \in I_A \wedge r \prec_C s \wedge \text{PhysReal}^+_A(r) \wedge \text{PhysReal}^+_A(s). \tag{101}$$

Under universal CMA,

$$\begin{aligned} r, s \in I_A \wedge r \prec_C s \wedge \text{CMA}(r) \wedge \text{CMA}(s) \\ \Longrightarrow \text{FurtherReal}_A(r, s). \end{aligned} \tag{102}$$

The relation records:

(i) one numerical bearer;
(ii) two members of its identity domain;

(iii) their order;
(iv) and positive physical realization at both.

It does not independently establish that the two realization contents are observably or physically unequal under a selected comparison criterion:

$$\mathrm{FurtherReal}_A(r,s) \not\Rightarrow \mathrm{CriterionDifference}_{\Gamma_A}(A;r,s). \tag{103}$$

Nor does it mean that one entity called *change* moves from r to s:

$$\mathrm{FurtherReal}_A(r,s) \not\Rightarrow \mathrm{ChangeObjectTransported}(r,s). \tag{104}$$

A state or content difference requires a separately defined comparison and warrant.

5.11 Unity of stage and multiplicity of realization

CMA combines two non-identical commitments:

(1) one common cosmic stage for all then-existing bearers;
(2) bearer-specific positive physical realization in every one of those bearers.

For $A, B \in \mathcal{S}_{\mathrm{phys}}(s)$,

$$\mathrm{CMA}(s) \Longrightarrow \mathrm{PhysReal}^+_A(s) \wedge \mathrm{PhysReal}^+_B(s). \tag{105}$$

However,

$$\mathrm{CMA}(s) \not\Rightarrow \mathrm{SamePhysicalState}(A,B;s), \tag{106}$$

$$\mathrm{CMA}(s) \not\Rightarrow \mathrm{SameRealizationContent}(A,B;s), \tag{107}$$

and

$$\mathrm{CMA}(s) \not\Rightarrow \begin{bmatrix} \mathrm{SameMagnitude}(A,B;s) \\ \wedge\ \mathrm{SameMechanism}(A,B;s) \\ \wedge\ \mathrm{SameRate}(A,B;s) \\ \wedge\ \mathrm{SameObservability}(A,B;s) \end{bmatrix}. \tag{108}$$

Stage unity is therefore not state identity.

The axiom does not assign one universal physical state to the totality of bearers, because the universe is not treated as one additional bearer with a state map. It states a universal relation across bearer-specific realizations.

No universal mechanism of change

CMA states universal occurrence, not universal mechanism.

For each bearer A, its physical realization may be grounded in different internal factors, external engagements, relations, exchanges, or mechanisms:

$$\mathcal{G}_A(s) = (\mathcal{I}_A(s), \mathcal{E}_A(s)).$$

CMA does not entail

$$\exists \mathcal{M}_{\text{univ}}\ \forall s \in \mathcal{S}_C \forall A \in \mathcal{S}_{\text{phys}}(s), \quad \text{MechanismOf}\left(\text{PhysReal}_A^{+}(s)\right) = \mathcal{M}_{\text{univ}}. \tag{109}$$

The universality lies in the occurrence of bearer-specific positive physical realization, not in one material process shared identically by all systems.

Unknown mechanism does not remove a bearer from CMA. Conversely, CMA does not license invention of an unspecified mechanism for a particular scientific application.

5.12 CMA is non-causal with respect to time and stage

CMA does not state that the cosmic stage, the ordering relation, or time causes physical realization.

Thus,

$$\text{CMA}(s) \not\Rightarrow \text{StageCausesChange}(s), \tag{110}$$

$$\text{CMA}(s) \not\Rightarrow \text{TimeCausesChange}(s), \tag{111}$$

and

$$\text{CMA}(s) \not\Rightarrow \text{OrderTransportsRealization}\left(\prec_C\right). \tag{112}$$

CMA relates each present bearer to its positive physical realization at the common stage. The causal and constitutive ground remains in actual physical systems and their physically realized factors and engagements.

The axiom itself is a governing proposition, not a physical force or mechanism operating on the bearers.

5.13 Co-presence of different bearers

Define common-stage co-presence by

$$\text{CoPresent}_{\text{C}}(A, B; s) \iff \text{Present}_{\text{C}}(A; s) \wedge \text{Present}_{\text{C}}(B; s). \tag{113}$$

For any $A, B \in \mathcal{S}_{\text{phys}}(s)$,

$$A, B \in \mathcal{S}_{\text{phys}}(s) \Longrightarrow \text{CoPresent}_{\text{C}}(A, B; s). \tag{114}$$

The relation means that the two bearer identities are realized at the same common cosmic stage.

It does not mean:

(i) spatial co-location;
(ii) physical contact;
(iii) causal interaction;
(iv) signal exchange;
(v) equal clock readings;
(vi) or equality of physical condition.

Accordingly,

$$\mathrm{CoPresent}_{\mathrm{C}}(A, B; s) \not\Rightarrow \mathrm{SpatiallyColocated}(A, B; s), \tag{115}$$

$$\mathrm{CoPresent}_{\mathrm{C}}(A, B; s) \not\Rightarrow \mathrm{SignalExchange}(A, B; s), \tag{116}$$

and

$$\mathrm{CoPresent}_{\mathrm{C}}(A, B; s) \not\Rightarrow \mathrm{CausalInfluence}(A, B; s). \tag{117}$$

Common-stage unity requires no instantaneous causal channel.

5.14 Spatial separation does not divide the common stage

Let

$$\mathrm{SpatiallySeparated}_R(A, B; s)$$

state that bearers A and B are spatially separated at s under a declared physical spatial reference R.

Then

$$\begin{aligned} A, B \in \mathcal{S}_{\mathrm{phys}}(s) \wedge \mathrm{SpatiallySeparated}_R(A, B; s) \\ \Longrightarrow \mathrm{CoPresent}_{\mathrm{C}}(A, B; s). \end{aligned} \tag{118}$$

Where signal propagation between them requires a nonzero operational interval,

$$\begin{aligned} A, B \in \mathcal{S}_{\mathrm{phys}}(s) \wedge \mathrm{SignalDelay}_{P,M}(A, B) > 0 \\ \Longrightarrow \mathrm{CoPresent}_{\mathrm{C}}(A, B; s). \end{aligned} \tag{119}$$

The conclusion does not follow from distance or signal delay. It follows from both bearers' membership in the same stage population. The additional conditions demonstrate that neither spatial separation nor delayed communication alters that membership.

Distance affects:

(a) interaction possibilities;
(b) propagation paths;
(c) record production;
(d) reception;

(e) synchronization procedures;
(f) and observational reconstruction.

It does not divide, postpone, deform, or reassign the common cosmic stage.

Different local conditions at one common stage

Bearers present at one common stage may realize different local physical conditions.

One terrestrial region may be illuminated while another is in darkness. One system may move relative to a selected reference while another is at relative rest. Different systems may possess unequal temperatures, pressures, biological conditions, developmental stages, or clock outputs.

All such differences are compatible with

$$\mathrm{CoPresent}_{\mathrm{C}}(A, B; s).$$

Thus,

$$\begin{aligned} &\mathrm{CoPresent}_{\mathrm{C}}(A, B; s) \wedge \mathrm{DifferentLocalConditions}(A, B; s) \\ &\quad \not\Rightarrow \mathrm{DifferentCosmicStages}(A, B). \end{aligned} \tag{120}$$

Night and day, local dates, seasonal states, and conventional time zones will be treated later as local physical or representational classifications. They do not multiply the universal cosmic succession.

5.15 Propagation and epistemic access

Common-stage membership is ontic. Scientific assignment of distant occurrences to one exact common stage is epistemic and may be difficult or unresolved.

A protocol- and model-relative warrant may be written

$$\mathrm{Warrant}_{P,M}\left[\mathrm{CoPresent}_{\mathrm{C}}(A, B; s)\right]. \tag{121}$$

Such warrant does not entail an instantaneous causal relation:

$$\mathrm{Warrant}_{P,M}\left[\mathrm{CoPresent}_{\mathrm{C}}(A, B; s)\right] \not\Rightarrow \mathrm{InstantaneousCausalChannel}(A, B; s). \tag{122}$$

Where the available records do not justify one exact s, the scientifically admissible result may be:

(i) an order relation;
(ii) a localization window;
(iii) a candidate-stage set;
(iv) or an unresolved attribution.

This limitation belongs to knowledge, records, and reconstruction. It does not divide an actual common stage or postpone the physical realization of a distant bearer.

5.16 Observation does not govern inclusion in CMA

An observer, detector, clock, instrument, laboratory, signal source, and record bearer are themselves physical systems wherever their bearer criteria are satisfied.

For an observer or instrument O,

$$\mathrm{CMA}(s) \wedge O \in \mathcal{S}_{\mathrm{phys}}(s) \Longrightarrow \mathrm{PhysReal}_O^+(s). \tag{123}$$

There is no physically stationary observer or measuring apparatus outside the common cosmic extension.

This statement does not independently prove CMA. It states the internal scope of the axiom: no qualified physical bearer is exempt merely because it functions as an observer, instrument, reference, or record producer.

5.17 CMA and detectability

Because physical realization is not identical with detection,

$$\mathrm{CMA}(s) \not\Rightarrow \forall A \in \mathcal{S}_{\mathrm{phys}}(s), \quad \mathrm{Detected}_{P,M,\varepsilon}(A, s). \tag{124}$$

CMA asserts positive realization, not universal observability.

Likewise,

$$\exists A \in \mathcal{S}_{\mathrm{phys}}(s), \quad \neg\,\mathrm{Detected}_{P,M,\varepsilon}(A, s) \not\Rightarrow \neg\,\mathrm{CMA}(s). \tag{125}$$

A finite null record remains bounded by its bearer attribution, variables, sensitivity, sampling, model, and protocol.

This does not make CMA immune to contradiction. It prevents one epistemically limited null result from being treated as an ontic non-occurrence without an adequate inference bridge.

5.18 The ontological counterinstance condition

For one declared stage s, a present bearer without positive physical realization contradicts the stage-indexed axiom:

$$\boxed{s \in \mathcal{S}_C \wedge A \in \mathcal{S}_{\mathrm{phys}}(s) \wedge \neg\,\mathrm{PhysReal}_A^+(s) \Longrightarrow \neg\,\mathrm{CMA}(s)}. \tag{126}$$

This is the direct logical counterinstance condition.

It is not an inference from non-detection:

The nondetection restraint is already fixed by Equation (33).

The evidential conditions required to warrant a bearer-complete counterinstance are developed in Section 16.

The distinction preserves both:

(a) the logical vulnerability of CMA to one genuine counterinstance;

(b) and the epistemic discipline required before asserting that such a counterinstance has been established.

What CMA establishes

CMA establishes that:

(1) every actual common cosmic stage falls within its scope;
(2) every physical bearer present at that stage falls within its scope;
(3) every such bearer has positive bearer-specific physical realization at that stage;
(4) the first cosmic stage is not excluded;
(5) newly formed, continuing, and ending bearers are not excluded;
(6) and spatial separation does not divide common-stage membership.

What CMA does not establish

CMA does not establish:

(a) one universal physical mechanism;
(b) equal changes among bearers;
(c) equal states, magnitudes, rates, or observability;
(d) instantaneous causal interaction;
(e) direct experimental access to every stage;
(f) an exact record-to-stage map;
(g) a metric duration;
(h) a private time for any bearer;
(i) a greatest cosmic stage;
(j) or the formation, persistence, and ending criteria of a particular bearer class.

Those matters require independent definitions, physical models, and evidential warrants.

6. Physical Identity Formation and Origin

6.1 Cosmic origin and bearer formation

Cosmic origin and bearer formation are distinct levels.

The first cosmic stage s_{C}^{0} is the origin stage of the universe as the totality of the physical systems initially realized there. It does not follow that every physical bearer existed at cosmic origin.

A bearer A may form at any stage $f_A \in \mathcal{S}_C$ satisfying its domain-appropriate identity criterion. Later-forming stars, organisms, cells, instruments, cities, and other systems begin their own identity histories within the same common cosmic ordering.

Thus,

$$\mathrm{PhysicalSystem}(A) \nRightarrow s_{\mathrm{C}}^{0} \in I_A. \tag{127}$$

For initially present bearers,

$$A \in \mathcal{S}_{\text{phys}}(s_{\mathrm{C}}^{0}) \Longrightarrow s_{\mathrm{C}}^{0} \in I_A. \tag{128}$$

6.2 The actual formation boundary

Define the attained formation boundary of bearer A by

$$\boxed{\text{AttainedFormation}_A(f) \iff f \in I_A \wedge \text{IdentityFormationRealized}_A(f) \wedge \neg\exists r \in I_A\,(r \prec_C f)}. \tag{129}$$

The definition requires three conditions:

(i) the bearer identity is realized at f;
(ii) identity-forming physical realization occurs there;
(iii) and no earlier member of the same bearer identity exists.

Leastness alone does not establish formation. The physical identity-forming occurrence remains necessary.

Postulate 6.1 (Actual Formation Boundary)**.** Every physically realized bearer has one and only one attained formation member:

$$\boxed{\forall A \in \mathcal{U}_{\text{phys}}, \quad \exists! f \in I_A \;\; \text{AttainedFormation}_A(f)}. \tag{130}$$

For that unique member, write

$$f_A := \iota f \in I_A \;\; \text{AttainedFormation}_A(f). \tag{131}$$

It follows that

$$f_A = \min_{\prec_C} I_A. \tag{132}$$

The equality identifies the already established formation member as the least identity member. It does not derive physical formation from order alone.

6.3 Formation-occurrence exclusivity

The identity-formation predicate may apply only at the formation boundary of the same numerical bearer:

$$\text{IdentityFormationRealized}_A(s) \Longrightarrow [s \in I_A \wedge \neg\exists r \in I_A\,(r \prec_C s)]\,. \tag{133}$$

Consequently, later repair, growth, assembly, reorganisation, or phase change within the persisting identity of A is not a second formation of that same bearer.

A physically similar later bearer may form, but it possesses its own numerical identity and its own formation member.

6.4 Formation as identity-forming physical change

Formation is the positive physical realization through which a bearer identity first becomes actual.

Therefore,

$$\mathrm{AttainedFormation}_A(f) \Longrightarrow \mathrm{PhysReal}^+_A(f). \tag{134}$$

This implication is classificatory. It states that physically realized formation belongs to the general genus of positive bearer-specific physical realization.

Define the derived identity-forming realization classification by

$$\boxed{\mathrm{FormationReal}_A(f) \Longleftrightarrow \mathrm{AttainedFormation}_A(f) \wedge \mathrm{PhysReal}^+_A(f)}. \tag{135}$$

Together with Equation (134), this yields

$$\mathrm{AttainedFormation}_A(f) \Longleftrightarrow \mathrm{FormationReal}_A(f). \tag{136}$$

The classification supplies the formation subtype used in the definition of ontic transformation. It does not assert that time, the common stage, or CMA causes the formation.

Formation also does not require an earlier state of the same bearer:

$$\mathrm{AttainedFormation}_A(f) \not\Rightarrow \exists r \in I_A\, (r \prec_C f). \tag{137}$$

Indeed, the right-hand proposition is excluded by the definition of the formation boundary.

Processes involving predecessor or contributing systems may precede or participate in the formation of A. Those are changes in those systems, not an earlier state of A.

6.5 Formation at cosmic origin and later formation

For every bearer initially present at cosmic origin,

$$A \in \mathcal{S}_{\mathrm{phys}}(s^0_{\mathrm{C}}) \Longrightarrow f_A = s^0_{\mathrm{C}}. \tag{138}$$

For a bearer formed after cosmic origin,

$$f_A \neq s^0_{\mathrm{C}} \Longrightarrow s^0_{\mathrm{C}} \prec_C f_A. \tag{139}$$

Both cases belong to the same cosmic ordering.

The difference concerns the bearer-specific formation member, not a different time or cosmic extension.

6.6 Ontic boundary and epistemic formation window

The actual formation boundary and scientific knowledge of that boundary have different types.

A protocol- and model-relative formation estimate is written

$$\text{EstimatedFormationWindow}_{P,M}(A, W), \qquad \varnothing \neq W \subseteq \mathcal{S}_C. \tag{140}$$

Where the estimate is warranted,

$$\begin{aligned}&\text{Warrant}_{P,M}[\text{EstimatedFormationWindow}_{P,M}(A, W)] \wedge \text{EstimatedFormationWindow}_{P,M}(A, W)\\ &\quad\Longrightarrow f_A \in W.\end{aligned} \tag{141}$$

The window does not mean that A possesses several beginnings or that identity formation is an extended temporal object.

It records only the limits of present localization.

Let $\text{FirstDetectionAt}_{P,M}(A, d)$ denote the protocol- and model-relative proposition that d is assigned to the first accepted detection of bearer A, and let $\text{FirstAcceptedRecordAt}_{P,M}(A, d)$ denote the analogous proposition for its first accepted record. These are epistemic assignments, not definitions of the ontic formation boundary. Accordingly,

$$\forall d \in \mathcal{S}_C, \quad \text{FirstDetectionAt}_{P,M}(A, d) \not\Rightarrow d = f_A, \tag{142}$$

$$\forall d \in \mathcal{S}_C, \quad \text{FirstAcceptedRecordAt}_{P,M}(A, d) \not\Rightarrow d = f_A. \tag{143}$$

Observation or record acceptance may occur after the bearer has already formed.

Physical origin of a later bearer

For a bearer B forming after cosmic origin, let $\mathcal{P} \subseteq \mathcal{U}_{\text{phys}}$ be a nonempty set of directly contributing physical bearers.

Define

$$\begin{aligned}\text{OriginatesAt}(B, \mathcal{P}, s) \iff\ & \text{AttainedFormation}_B(s) \wedge s^0_{\text{C}} \prec_C s \wedge \varnothing \neq \mathcal{P} \subseteq \mathcal{U}_{\text{phys}}\\ & \wedge \forall A \in \mathcal{P} \left[\text{Present}_{\text{C}}(A; s) \wedge \text{PhysReal}^+_A(s)\right]\\ & \wedge \text{PhysicalOriginLink}(\mathcal{P}, s, B).\end{aligned} \tag{144}$$

The primitive relation

$$\text{PhysicalOriginLink}(\mathcal{P}, s, B)$$

states that the declared contributors are physically linked to the formation of B. Formal membership in $\mathcal{P}$ does not establish that link by itself.

The relation does not treat the cosmic stage or time as a contributor.

6.7 Contributors need not end

A contributor may remain physically realized after the formation of the new bearer.

Define

$$\text{ContinuesAfter}(A,s) \iff A \in \mathcal{U}_{\text{phys}} \wedge s \in I_A \wedge \exists u \in I_A\,(s \prec_C u). \tag{145}$$

Then

$$\text{OriginatesAt}(B,\mathcal{P},s) \not\Rightarrow \forall A \in \mathcal{P}, \quad \neg\,\text{ContinuesAfter}(A,s). \tag{146}$$

A parent organism, manufacturing system, environmental system, or other contributor may participate in the formation of a new bearer while its own identity continues.

Therefore, physical origin is broader than successor production. Successorship will require the ending of a predecessor identity and the formation of a new identity under a separately warranted production link.

6.8 Origin attribution requires warrant

Scientific assertion of a particular physical origin relation requires a separately validated evidential bridge:

$$\text{OriginWarrant}_{P,M}\left[\text{OriginatesAt}(B,\mathcal{P},s)\right]. \tag{147}$$

Similarity, spatial proximity, naming continuity, or observational sequence alone is insufficient.

Where the evidence resolves only a window W, the admissible claim must retain that resolution rather than assert one exact s.

6.9 Scope summary

This section establishes:

$$\boxed{\forall A \in \mathcal{U}_{\text{phys}}, \quad \exists! f_A \in I_A} \tag{148}$$

such that f_A is the unique identity-forming boundary of A.

It also establishes that:

(1) formation is positive physical realization that begins one bearer identity;
(2) formation requires no earlier state of that same bearer;
(3) cosmic origin and later bearer formation are distinct;
(4) a formation window is epistemic rather than ontologically plural;
(5) physical-origin attribution requires an actual physical link;
(6) and contributors to formation need not end.

This section does not yet define:

(a) the complete bearer state map;
(b) identity-domain convexity;
(c) the complete physical-history tuple;
(d) UCC;

(e) identity ending;
(f) or successor production.

7. Identity, State, and Physical History

7.1 Physical identity and bearer individuality

Physical identity states what makes one actually realized physical bearer that bearer rather than another bearer, an arbitrary collection, a property, a record, or a merely similar later system.

For every $A \in \mathcal{U}_{\text{phys}}$, bearer identity is numerical identity:

$$A = A.$$

It is not merely membership in a physical class. Two systems may possess the same composition, design, function, genetic pattern, name, location, or visible condition while remaining numerically distinct bearers.

Accordingly,

$$\text{PhysicallySimilar}_{\Gamma}(A, B) \not\Rightarrow A = B. \tag{149}$$

The criterion Γ may establish similarity or equivalence relative to selected physical characteristics. It does not transfer numerical identity from one bearer to another.

Conversely, one bearer may undergo substantial physical alteration while its numerical identity continues. Identity persistence is therefore not defined by complete invariance of material constituents, selected properties, function, appearance, or location.

The bearer identity criterion

Every scientifically asserted physical bearer requires a domain-appropriate identity criterion.

Let

$$\Gamma_A^{\text{id}}$$

denote the declared identity criterion governing bearer A. The criterion specifies the physical conditions under which:

(i) the bearer is first realized;
(ii) its numerical identity continues through physical alteration;
(iii) changes in constituents, organization, function, or relations remain compatible with persistence;
(iv) and the bearer identity ceases.

The criterion does not create the physical identity:

$$\text{DeclaredIdentityCriterion}\left(\Gamma_A^{\text{id}}\right) \not\Rightarrow \text{PhysicalSystem}(A). \tag{150}$$

Rather, it supplies the conceptual and scientific basis for identifying and attributing an already physical bearer.

A valid criterion must match the bearer class. A criterion suitable for a molecule may be inadequate for a cell, organism, city, star, lineage, or distributed system.

No one universal constituent percentage, functional capacity, spatial boundary, genetic pattern, or visible form governs identity in every physical domain.

7.2 Identity is not naming or classification

A physical name may continue after the bearer has ended, and a bearer may continue despite a change of name or classification.

Thus,

$$\mathrm{SameName}(A_r, A_s) \not\Rightarrow \mathrm{SameNumericalBearer}(A_r, A_s), \tag{151}$$

and

$$\mathrm{DifferentName}(A_r, A_s) \not\Rightarrow \mathrm{DifferentNumericalBearer}(A_r, A_s). \tag{152}$$

Classification and naming are epistemic or conventional activities. Bearer identity is a physical condition.

This distinction is necessary in cases involving repaired machines, renamed cities, biological development, phase alteration, cloned or reproduced organisms, and successor systems resembling their predecessors.

7.3 The identity domain

The identity domain of A is

$$\boxed{I_A = \{s \in \mathcal{S}_C \mid \mathrm{ExistsAs}(A, s)\}}. \tag{153}$$

Because A is an actually realized physical bearer, the nonemptiness condition is already fixed by Equation (25).

Every identity member belongs to the one common cosmic domain:

$$I_A \subseteq \mathcal{S}_C. \tag{154}$$

The inclusion means that every realization of A occurs within the same universal cosmic succession. It does not give A an independent time or private stage series.

The unique formation member f_A established in Section 6 is the least identity-domain member by Equation (132).

The greatest member and identity-ending classification are introduced later, because their physical meaning depends upon the full ending and transformation analysis.

7.4 Reflexive order within a bearer history

For compact bearer-history statements, define the reflexive closure of the cosmic ordering by

$$r \preceq_C s \iff r = s \lor r \prec_C s. \tag{155}$$

This notation introduces no new temporal relation. It is derived from the governing strict order $\prec_C$.

For $r, s \in I_A$, the relation

$$r \preceq_C s$$

states only that the first bearer realization is identical to or earlier than the second within the common cosmic ordering.

7.5 Identity-Domain Convexity

Principle 7.1 (Identity-Domain Convexity)**.** If the same numerical bearer identity is realized at two bounding common cosmic stages, it remains realized at every common cosmic stage ordered between them:

$$\boxed{\begin{aligned} \mathrm{IDC}: \quad & \forall A \in \mathcal{U}_{\mathrm{phys}}\, \forall r, t \in I_A\, \forall s \in \mathcal{S}_C, \\ & r \prec_C s \land s \prec_C t \Longrightarrow s \in I_A. \end{aligned}} \tag{156}$$

The principle excludes an ontological gap inside the continuous realization of one numerical identity.

It does not assert:

(a) topological continuity;
(b) metric continuity;
(c) infinitely many identity members;
(d) observational access to every member;
(e) or complete physical invariance between the bounding stages.

Convexity concerns identity persistence, not absence of change.

It does not produce the formation member, the ending member, or the physical mechanisms through which identity is maintained.

7.6 Bearer-relative identity continuation

For $r, t \in \mathcal{S}_C$, define identity continuation between the two stages by

$$\begin{aligned} \mathrm{IdCont}_A(r, t) \iff & r, t \in I_A \land r \preceq_C t \\ & \land \forall s \in \mathcal{S}_C \left[r \preceq_C s \land s \preceq_C t \Longrightarrow s \in I_A \right]. \end{aligned} \tag{157}$$

Under Identity-Domain Convexity,

$$r,t \in I_A \wedge r \preceq_C t \Longrightarrow \mathrm{IdCont}_A(r,t). \tag{158}$$

The predicate records continued realization of the same numerical bearer through the bounded portion of its history.

It does not mean that every constituent, property, function, state component, or spatial relation remains unchanged.

7.7 Ontological identity gaps and record gaps

An ontological identity gap and an evidential record gap have different logical types.

Under Identity-Domain Convexity,

$$r,t \in I_A \wedge r \prec_C s \prec_C t \Longrightarrow s \in I_A. \tag{159}$$

Therefore, a physically established absence of A at an intermediate stage is incompatible with the claim that the same numerical identity is realized at both bounding stages.

A later bearer may resemble the earlier bearer, occupy the same location, receive the same name, or contain some of the same material. Those facts do not restore an identity that physically ceased.

By contrast,

$$\neg\, \mathrm{RecordAvailable}_{P,M}(A;s) \not\Rightarrow s \notin I_A. \tag{160}$$

A record may be missing because of:

(i) incomplete sampling;
(ii) loss or destruction of records;
(iii) transmission failure;
(iv) limited detection;
(v) inaccessible location;
(vi) attribution uncertainty;
(vii) or reconstruction limits.

A record gap becomes evidence for an identity gap only through an independently validated bearer-specific inference.

7.8 One-stage bearer histories

V29/F9 does not require every bearer identity to extend across two or more distinct common cosmic stages.

A formally admissible identity domain is

$$I_A = \{f_A\}. \tag{161}$$

Such a bearer forms at its only identity member. The later ending section may also classify that member as the stage at which the identity ends, where the relevant physical conditions are satisfied.

A one-stage history is not physically trivial merely because it contains no ordered pair of distinct identity members. Formation and possible ending are positive bearer-specific physical realizations.

However, universal statements restricted to bearer-relative later members must not be presented as non-vacuously realized when the domain contains no such member. This distinction will govern the formulation of UCC in the following section.

The ontic bearer-state map

For every physical bearer A, let

$$\Omega_A^{\mathrm{ont}}$$

be the codomain of bearer states treated as ontically complete relative to:

(a) the adopted physical ontology;
(b) the declared bearer boundary;
(c) and the identity criterion governing A.

Define the ontic bearer-state map by

$$\boxed{X_A : I_A \longrightarrow \Omega_A^{\mathrm{ont}}}. \tag{162}$$

For every $s \in I_A$,

$$X_A(s)$$

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

The phrase *ontically complete* does not assert that an observer or model has exhaustive knowledge of the state. It states that $X_A(s)$ is intended to represent the bearer state itself rather than one selected measurement or model projection.

7.9 Cosmic stage and bearer state

A common cosmic stage and a bearer state are different types:

$$\mathrm{Type}(s) = \textsf{CommonCosmicStage}, \qquad \mathrm{Type}(X_A(s)) = \textsf{BearerPhysicalState}. \tag{163}$$

Therefore,

$$s \not\equiv X_A(s). \tag{164}$$

Nevertheless, the phrase *the stage of bearer A at s* may be used in explanatory prose to denote the physical state $X_A(s)$ realized by A at that position in the common cosmic ordering.

It does not denote a private cosmic stage belonging only to A.

This terminological rule preserves two facts simultaneously:

(i) the common cosmic stage is universal;
(ii) the physical state realized there is bearer-specific.

7.10 State components and attributable sub-descriptions

Let $\mathcal{K}_A$ be a declared index domain of physical components, regions, relations, or attributable sub-descriptions of bearer A.

For $k \in \mathcal{K}_A$, let

$$\pi_{A,k} : \Omega_A^{\text{ont}} \longrightarrow \Omega_{A,k}$$

be a declared ontic projection, and define

$$X_{A,k} := \pi_{A,k} \circ X_A. \tag{165}$$

A component may represent a molecular site, cellular region, material property, spatial relation, field value, structural feature, functional subsystem, or another bearer-attributable physical aspect.

The index k is analytical. It does not imply that every bearer is permanently decomposable into independent components.

A component claim transfers to the bearer only under valid physical attribution:

$$\begin{aligned} &X_{A,k}(r) \not\equiv_{\Gamma_{A,k}} X_{A,k}(t) \\ &\quad \wedge \text{ValidComponentAttribution}_A(k; r, t) \\ &\qquad \Longrightarrow X_A(r) \not\equiv_{\Gamma_A} X_A(t), \end{aligned} \tag{166}$$

where the bearer criterion Γ_A explicitly includes the selected component criterion $\Gamma_{A,k}$.

Without the attribution and criterion bridge, a local record may not be transferred automatically to the whole bearer.

7.11 Criterion-relative state equivalence

For $r, t \in I_A$, write

$$X_A(r) \equiv_{\Gamma_A} X_A(t) \tag{167}$$

for equivalence of the two bearer states under the declared criterion Γ_A.

This is not necessarily complete physical identity of state. The criterion may select particular properties, tolerances, relations, or functional regimes.

Accordingly,

$$X_A(r) \equiv_{\Gamma_A} X_A(t) \not\Rightarrow X_A(r) = X_A(t). \tag{168}$$

Even complete ontic state equality, were it physically established, would not identify the stages:

$$X_A(r) = X_A(t) \nRightarrow r = t. \tag{169}$$

Where $r \prec_C t$, recurrence or equivalence remains a later physical realization and does not reverse the cosmic order.

7.12 Model-relative state representation

A protocol or model does not automatically possess the complete ontic state of the bearer.

Let

$$\rho_{A,M} : \Omega_A^{\text{ont}} \dashrightarrow \Omega_{A,M} \tag{170}$$

be a partial model-relative representation map.

Its induced stage domain is

$$I_{A,M} := \{s \in I_A \mid X_A(s) \in \text{Dom}(\rho_{A,M})\}. \tag{171}$$

The model-relative state map is then

$$X_{A,M} : I_{A,M} \longrightarrow \Omega_{A,M}, \qquad X_{A,M}(s) := \rho_{A,M}(X_A(s)). \tag{172}$$

The codomain $\Omega_{A,M}$ may contain selected variables, observables, estimated parameters, reconstructed states, or coarse-grained descriptions.

It is not identified with Ω_A^{ont}.

7.13 Model equality does not establish ontic equality

For $r, t \in I_{A,M}$,

$$X_{A,M}(r) = X_{A,M}(t) \nRightarrow X_A(r) = X_A(t). \tag{173}$$

Likewise,

$$X_{A,M}(r) \equiv_{\Gamma_{A,M}} X_{A,M}(t) \nRightarrow X_A(r) \equiv_{\Gamma_A} X_A(t). \tag{174}$$

The converse requires an independently justified completeness bridge showing that the selected model representation is adequate for the particular bearer-level claim.

A flat graph, unchanged sequence sample, equal clock output, stable measurement, or repeated image may therefore establish equivalence only within its declared representation and sensitivity.

It does not establish complete physical stasis.

Model difference and bearer attribution

A difference in model outputs does not automatically establish a difference in bearer state. It may arise from measurement noise, calibration change, reconstruction assumptions, sampling variation, or misattribution.

A valid transition requires a declared evidential bridge:

$$\begin{aligned} &X_{A,M}(r) \not\equiv_{\Gamma_{A,M}} X_{A,M}(t) \\ &\quad \wedge \text{ValidatedRepresentationBridge}_{A;P,M}(r,t) \\ &\quad\quad \Longrightarrow \text{Warrant}_{P,M}\left[X_A(r) \not\equiv_{\Gamma_A} X_A(t)\right]. \end{aligned} \tag{175}$$

The conclusion is epistemically warranted under P, M. The warrant does not enter the ontic state difference as one of its physical constituents.

7.14 Cross-bearer state comparison

States of different bearers may belong to different ontic codomains:

$$X_A(s) \in \Omega_A^{\text{ont}}, \qquad X_B(t) \in \Omega_B^{\text{ont}}.$$

Direct equality is therefore not presumed.

A cross-bearer comparison requires declared maps

$$\chi_A : \Omega_A^{\text{ont}} \longrightarrow \mathcal{C}, \qquad \chi_B : \Omega_B^{\text{ont}} \longrightarrow \mathcal{C}, \tag{176}$$

into a common comparison codomain $\mathcal{C}$.

Only then may one state, for example,

$$\chi_A(X_A(s)) \equiv_{\Gamma_{\mathcal{C}}} \chi_B(X_B(t)). \tag{177}$$

Such equivalence remains criterion-relative. It neither identifies the bearers nor their stages.

7.15 The physical history of a bearer

Golden formulation: physical history of a bearer

Definition 7.2 (Physical history)**.** The physical history of bearer A is

$$\boxed{\mathcal{H}_A = (I_A, \prec_C|_{I_A}, X_A)}. \tag{178}$$

The three components state:

(i) the common cosmic stages at which the identity is realized;
(ii) the restriction of the universal earlier–later ordering to those stages;
(iii) and the bearer-specific physical states realized there.

The history is not an additional physical bearer and not a private time. It is the ordered physical history of one bearer within the common cosmic extension.

The physical history is not the record archive

The complete physical history $\mathcal{H}_A$ and the available record archive of A are different objects. Let

$$\mathcal{R}_{A;P,M}$$

denote the accepted record set attributed to A under protocol P and model M.

Then

$$\mathcal{R}_{A;P,M} \not\equiv \mathcal{H}_A. \tag{179}$$

The record archive may be incomplete, indirect, delayed, damaged, selective, or model-dependent.

A physical record is itself realized in a record bearer and possesses its own physical history. It may represent or constrain selected aspects of the source history without becoming the source state or cosmic stage.

7.16 Reconstructed history

A reconstructed history is written schematically as

$$\widehat{\mathcal{H}}_{A;P,M} = \mathrm{Reconstruct}_{P,M}\left(\mathcal{R}_{A;P,M}\right). \tag{180}$$

In general,

$$\widehat{\mathcal{H}}_{A;P,M} \not\equiv \mathcal{H}_A. \tag{181}$$

The reconstruction may warrant:

(a) an ordered sequence of physical conditions;
(b) a formation or ending window;
(c) a lineage or transformation relation;
(d) a bounded state estimate;
(e) or a set of admissible historical models.

It need not identify every member of I_A, the complete state at every member, or one exact common cosmic stage for every reconstructed occurrence.

7.17 Same class and different physical histories

Two bearers may belong to the same class while possessing different physical histories:

$$\mathrm{SameClass}(A, B) \not\Rightarrow \mathcal{H}_A = \mathcal{H}_B. \tag{182}$$

Different histories may result from:

(i) different formation conditions;
(ii) different constituent organization;
(iii) different environments and interactions;
(iv) different damage, repair, disease, or recovery;
(v) different motion and spatial relations;
(vi) different interventions;
(vii) or different transformation and ending conditions.

Class membership permits structured comparison. It does not erase bearer individuality.

Likewise,

$$\mathcal{H}_A \neq \mathcal{H}_B \nRightarrow \text{DifferentCosmicTimes}(A, B). \tag{183}$$

Both histories remain ordered by restrictions of the same $\prec_C$.

7.18 Composite identity and constituent histories

For a composite bearer A, the histories of its constituents and the history of the composite are related but non-identical.

For a constituent p,

$$\text{PartOf}(p, A; s) \nRightarrow I_p = I_A. \tag{184}$$

A constituent may form before the composite, end during the composite history, be replaced while the composite persists, or continue after the composite identity ends.

Thus,

$$\text{ConstituentSurvivesAfter}(p, A; s) \nRightarrow \text{CompositeSurvivesAfter}(A; s), \tag{185}$$

and

$$\text{ConstituentReplacement}(p, A; r, t) \nRightarrow \neg\,\text{IdCont}_A(r, t). \tag{186}$$

The identity criterion for the composite determines whether the organization and relations necessary for its identity remain realized.

7.19 Material continuity and identity continuity

Persistence of some material content is neither universally sufficient nor universally necessary for persistence of one bearer identity.

Therefore,

$$\text{MaterialContinuity}(A; r, t) \nRightarrow \text{IdCont}_A(r, t), \tag{187}$$

and

$$\mathrm{IdCont}_A(r,t) \nRightarrow \mathrm{SameCompleteConstituentSet}(A;r,t). \tag{188}$$

The first restraint is important when material remains persist after a city, organism, machine, or other composite bearer has ceased.

The second is important for organisms, cells, repaired systems, and open systems whose constituents change while their bearer identity continues.

7.20 Genetic continuity and bearer identity

Genetic evidence may contribute strongly to identity attribution in biological domains, but no unqualified genetic relation defines every bearer identity.

A genetic similarity or continuity relation satisfies

$$\mathrm{GeneticContinuity}_{P,M}(A,B) \nRightarrow A = B. \tag{189}$$

Genetic continuity may support lineage, organismal, cellular, or molecular identity claims only under the appropriate bearer criterion and attribution bridge.

Conversely, genetic alteration in a component does not automatically end the identity of the cell, organism, tissue, or lineage containing it.

The detailed genetic hierarchy and evidential bridges are retained for the cross-domain application section.

Open and distributed histories

An open bearer may exchange constituents and physical quantities while its identity continues. A distributed bearer may possess spatially separated components and delayed internal records.

Neither condition creates an independent time.

For a distributed bearer A,

$$I_A \subseteq \mathcal{S}_C \tag{190}$$

remains the governing temporal relation.

Whether distant components constitute one distributed bearer, several interacting bearers, or nested bearers depends upon the declared physical identity criterion. It is not decided by spatial separation alone and does not require instantaneous communication.

Bearer history and local physical phases

Developmental, functional, clinical, material, or astronomical phases may partition or classify portions of a bearer history.

Let

$$\Phi_{A,\kappa} \subseteq I_A$$

denote the members classified under phase criterion κ.

Such a phase is a coarse-grained classification of bearer states. It is not a separate temporal domain.

Different phases may include growth, maturity, disease, recovery, stability, degradation, migration, orbital recurrence, or terminal transformation.

The phase label does not replace the underlying states or the common cosmic ordering.

No private time series

The state map

$$X_A : I_A \to \Omega_A^{\mathrm{ont}}$$

may be represented as an ordered bearer-state series for analytical purposes.

That representation does not constitute a separate time belonging to A.

The ordering remains

$$\prec_C |_{I_A}.$$

Therefore,

$$\mathrm{StateSeries}(X_A, I_A) \not\Rightarrow \mathrm{PrivateTime}(A). \tag{191}$$

The unity belongs to the universal cosmic ordering. The multiplicity belongs to the physical histories and states of the bearers.

8. Universal Change Continuity, Stability, and Recurrence

8.1 The bearer-relative later domain

For every physical bearer A, define its bearer-relative later domain by

$$I_A^+ := \{s \in I_A \mid \exists r \in I_A \, (r \prec_C s)\}. \tag{192}$$

Equivalently,

$$s \in I_A^+ \iff \mathrm{LaterInHistory}_A(s). \tag{193}$$

The set I_A^+ contains precisely those members of the bearer identity domain that are later than at least one other member of the same history.

It excludes the unique formation member f_A, because no member of I_A precedes f_A.

A globally later cosmic stage need not belong to I_A^+. A bearer may first form at a stage long after cosmic origin. The relevant condition is not whether the cosmic stage is later than s_{C}^0, but whether the bearer itself has an earlier identity member.

8.2 Universal Change Continuity

Golden formulation: Universal Change Continuity

Definition 8.1 (Universal Change Continuity)**.** For a physical bearer A,

$$\boxed{\mathrm{UCC}(A) \iff \mathrm{PhysicalSystem}(A) \wedge \forall s \in I_A^+, \quad \mathrm{PhysReal}_A^+(s)}. \tag{194}$$

Universal Change Continuity states that every bearer-relative later member of the identity history of A realizes positive bearer-specific physical change.

It does not introduce an additional physical mechanism. It is the bearer-history expression of the universal stage-level commitment already stated by CMA.

The equivalent conditional form is

$$\mathrm{UCC}(A) \iff \mathrm{PhysicalSystem}(A) \wedge \forall s \in I_A, \left[\mathrm{LaterInHistory}_A(s) \implies \mathrm{PhysReal}_A^+(s)\right]. \tag{195}$$

The two forms have the same scope. The first is more compact; the second makes the bearer-relative later condition explicit.

8.3 The stage-indexed bearer form

Define

$$\mathrm{UCC}(A, s) \iff A \in \mathcal{S}_{\mathrm{phys}}(s) \wedge \mathrm{LaterInHistory}_A(s) \wedge \mathrm{PhysReal}_A^+(s). \tag{196}$$

This predicate states one bearer-relative later realization at one common cosmic stage.

It does not state that A continues after s. The stage s may be an identity-ending member, provided that it is later than an earlier member of the same history.

Define the later-history realization classification by

$$\mathrm{LaterReal}_A(s) \iff \mathrm{LaterInHistory}_A(s) \wedge \mathrm{PhysReal}_A^+(s). \tag{197}$$

Thus,

$$\mathrm{UCC}(A, s) \implies \mathrm{LaterReal}_A(s). \tag{198}$$

Formation-stage realization and later-history realization are mutually exclusive because formation has no earlier member in I_A, whereas $\mathrm{LaterReal}_A(s)$ requires one.

Identity-ending realization may overlap with later-history realization when the bearer has a nontrivial history and ends at a later member.

8.4 UCC as a consequence of CMA

Proposition 8.2 (Stage-indexed bearer consequence of CMA)**.** For every $A \in \mathcal{U}_{\mathrm{phys}}$ and $s \in \mathcal{S}_C$,

$$\mathrm{CMA}(s) \wedge A \in \mathcal{S}_{\mathrm{phys}}(s) \wedge \mathrm{LaterInHistory}_A(s) \Longrightarrow \mathrm{UCC}(A, s). \tag{199}$$

Proof. Let A and s satisfy the antecedent. From $\mathrm{CMA}(s)$ and $A \in \mathcal{S}_{\mathrm{phys}}(s)$, it follows that

$$\mathrm{Present}_{\mathrm{C}}(A; s) \wedge \mathrm{PhysReal}^{+}_{A}(s).$$

The remaining antecedent supplies $\mathrm{LaterInHistory}_A(s)$. These clauses satisfy the definition of $\mathrm{UCC}(A, s)$.

Proposition 8.3 (Universal bearer consequence of CMA)**.**

$$\boxed{\mathrm{CMA} \Longrightarrow \forall A \in \mathcal{U}_{\mathrm{phys}}, \quad \mathrm{UCC}(A)}. \tag{200}$$

Proof. Fix an arbitrary $A \in \mathcal{U}_{\mathrm{phys}}$, and let $s \in I^{+}_{A}$. Then $s \in I_A$, so $A \in \mathcal{S}_{\mathrm{phys}}(s)$. Universal CMA gives

$$\mathrm{PhysReal}^{+}_{A}(s).$$

Because s was arbitrary in I^{+}_{A}, every bearer-relative later member satisfies the positive-realization predicate. Therefore $\mathrm{UCC}(A)$.

The derivation uses CMA and bearer membership. It does not derive physical change from logic, convexity, the formation boundary, or the definition of time.

8.5 Nontrivial bearer history

A universal statement over an empty later domain may be logically true without any later bearer realization occurring.

Define

$$\mathrm{NontrivialHistory}(A) \Longleftrightarrow I^{+}_{A} \neq \varnothing. \tag{201}$$

Equivalently,

$$\mathrm{NontrivialHistory}(A) \Longleftrightarrow \exists r, s \in I_A \, (r \prec_C s) \, . \tag{202}$$

Define non-vacuously realized continuity by

$$\mathrm{UCC}^{+}(A) \Longleftrightarrow \mathrm{UCC}(A) \wedge \mathrm{NontrivialHistory}(A). \tag{203}$$

Therefore,

$$\mathrm{CMA} \Longrightarrow \forall A \in \mathcal{U}_{\mathrm{phys}}, \Big[\mathrm{NontrivialHistory}(A) \Longrightarrow \mathrm{UCC}^{+}(A)\Big] \, . \tag{204}$$

The nontrivial-history condition does not add change to the bearer. It records that the history actually contains at least one member later than another.

A one-stage bearer may possess identity-forming and identity-ending physical realization at its sole member while having

$$I_A^+ = \varnothing.$$

Such a history is physically admissible, but it is not described as non-vacuously extended continuity.

What continuity means

The word *continuity* in UCC means uninterrupted applicability of positive bearer-specific physical realization throughout every later member of the persisting identity domain.

It does not assert:

(i) metric or topological continuity;
(ii) infinitely many stages;
(iii) an immediate successor relation between stages;
(iv) one continuous material called change;
(v) one mechanism operating unchanged throughout the history;
(vi) equal magnitude or rate of realization;
(vii) or separate instrumental resolution of every member.

Identity-Domain Convexity prevents internal gaps in the realization of one numerical identity. UCC states positive physical realization at every bearer-relative later member. The two commitments are complementary but non-identical:

$$\mathrm{IDC} \not\Rightarrow \mathrm{UCC}(A), \qquad \mathrm{UCC}(A) \not\Rightarrow \mathrm{IDC}. \tag{205}$$

IDC concerns where the identity remains realized. UCC concerns what is physically asserted at its later members.

8.6 No continuation beyond identity ending

UCC applies only within I_A.

It does not assert that the bearer continues after its identity ends:

$$\mathrm{UCC}(A) \not\Rightarrow \exists u \in I_A\,(e_A \prec_C u). \tag{206}$$

When A ends, its numerical identity no longer possesses later members. Physical material, energy, components, records, outcomes, or successor bearers may continue, but those continuations are not later states of the ended numerical identity A.

This boundary prevents UCC from being confused with conservation of material content or persistence of successor systems.

Universality without identical realization

For $r, s \in I_A^+$, UCC gives

$$\mathrm{PhysReal}_A^+(r) \wedge \mathrm{PhysReal}_A^+(s).$$

It does not entail that the two realizations have the same:

(a) content;
(b) magnitude;
(c) mechanism;
(d) spatial distribution;
(e) rate;
(f) functional effect;
(g) or observability.

Similarly, UCC for two different bearers does not make their histories or changes identical.

The universality concerns the occurrence of bearer-specific realization, not uniformity of the physical world.

8.7 Stability as criterion-relative persistence

Stability is persistence within a declared physical regime, pattern, range, or tolerance. It is not complete stasis.

Let Q_A be a declared bearer quantity or state projection, $J \subseteq I_A$ a nonempty investigated identity subdomain, and $\mathcal{R}_{Q,\epsilon}$ the accepted stability region under tolerance ϵ.

Define

$$\mathrm{Stable}_{Q,\epsilon,J}(A) \Longleftrightarrow \forall s \in J, \quad Q_A(s) \in \mathcal{R}_{Q,\epsilon}. \tag{207}$$

The predicate concerns the selected quantity and tolerance. Therefore,

$$\mathrm{Stable}_{Q,\epsilon,J}(A) \not\Rightarrow \forall s \in J, \quad \neg\, \mathrm{PhysReal}_A^+(s). \tag{208}$$

A bearer may remain structurally, functionally, clinically, dynamically, or observationally stable while realizing molecular, thermal, relational, regulatory, mechanical, or environmental changes.

Stability is informative. It states that a declared regime is maintained. It does not state that every physically relevant part, property, process, or relation is unchanged.

Relative rest

Kinematic rest is a relation between a bearer and a selected physical reference.

A bearer may remain at one position relative to one reference while undergoing internal change, participating in wider motion, or changing relative to another reference.

Therefore,

$$\text{AtRest}_R(A;J) \not\Rightarrow \text{CompletePhysicalStasis}(A;J). \tag{209}$$

The full definition of physical motion and spatial reference is deferred to Section 11. The present relation establishes only that absence of selected positional change is not absence of all physical realization.

8.8 Equilibrium and steady-state descriptions

Equilibrium and steady state are model- and variable-relative classifications.

A vanishing net flux does not require every contributing flux to vanish:

$$\sum_i J_i = 0 \not\Rightarrow \forall i, \quad J_i = 0. \tag{210}$$

Likewise, constancy of one selected quantity under a model parameter λ,

$$\frac{dQ_A}{d\lambda} = 0, \tag{211}$$

does not establish equality of the complete ontic state across the bearer history.

The symbol λ is a declared model or operational parameter. It is not identified with T_{ITOF}.

A stationary equation becomes an adverse case for UCC only when the represented variables and relations are warranted to be bearer-complete, the same numerical identity persists over a nontrivial history, and complete physical stasis is scientifically established.

8.9 Recurrence without temporal reversal

For $r, s \in I_A$, suppose

$$r \prec_C s \wedge X_A(r) \equiv_{\Gamma_A} X_A(s). \tag{212}$$

Then

$$r \neq s \wedge \neg(s \prec_C r). \tag{213}$$

The later state may resemble or equal the earlier state under the declared criterion, but the stages remain distinct and irreversibly ordered.

Recurrence therefore does not imply:

(i) restoration of an earlier cosmic stage;
(ii) reversal of the bearer history;
(iii) deletion of the intervening realizations;
(iv) or equality of every unselected bearer component.

A patient may be ill, recover, and later become ill again. The second illness may satisfy the same clinical criterion as the first, but it is a later physical realization in the continuing history of the patient.

Likewise, a clock display, orbital position, season, local night condition, or migrating animal may later return to a condition similar to an earlier one without returning to an earlier stage.

8.10 Periodic representations

A periodic model may satisfy

$$Q_A(\lambda + T) = Q_A(\lambda). \tag{214}$$

This equality concerns the selected quantity Q_A under model parameter λ.

It does not establish

$$X_A(s_{\lambda+T}) = X_A(s_\lambda), \tag{215}$$

unless an independently warranted completeness bridge is supplied.

Even complete state recurrence would not identify the two common cosmic stages. The ordering remains fixed.

8.11 Cumulative manifestation

A physically realized change may remain below the resolution of successive records and become noticeable only after accumulation.

Let

$$r_1 \prec_P r_2 \prec_P \cdots \prec_P r_n$$

be records ordered under protocol P, and let $O(r_i)$ be their typed outputs.

A cumulative pattern may satisfy

$$\begin{aligned} &\forall i < n, \quad d_{P,D}\left(O(r_i), O(r_{i+1})\right) \le \varepsilon_{P,D}, \\ &d_{P,D}\left(O(r_1), O(r_n)\right) > \varepsilon_{P,D}. \end{aligned} \tag{216}$$

This pattern does not entail that the entire physical alteration occurred at one uniquely identified stage:

$$(216) \not\Rightarrow \exists! s \in I_A \ \text{EntireAlterationOccurredAt}(A, s). \tag{217}$$

An archaeological stone may display no resolved macroscopic difference over several short intervals and later show a crack, surface loss, colour change, or erosion. The later manifestation may result from the accumulation and interaction of many earlier bearer-specific physical realizations.

Prior non-detection does not establish prior stasis. Later detection does not compress the complete alteration into the detection stage.

Noticeability and exact-stage restraint

The first record at which a difference crosses a detector or decision threshold does not necessarily identify the first physical realization contributing to that difference:

$$\mathrm{FirstDetectedDifference}_{P,M,D}(A; r_n) \not\Rightarrow \mathrm{FirstPhysicalRealizationAt}(A; s_n). \tag{218}$$

The physical bearer, detector, environment, and record chain all undergo their own changes. Sampling and threshold crossing may occur after a progressive, localized, or cumulative physical history.

A scientifically justified result may therefore be a manifestation window, an order bound, or a candidate-stage set rather than one exact cosmic stage.

8.12 Logical counterinstance to UCC

For a physical bearer A, one genuine later identity member without positive physical realization contradicts UCC:

$$\boxed{\mathrm{PhysicalSystem}(A) \wedge s \in I_A^+ \wedge \neg\,\mathrm{PhysReal}_A^+(s) \Longrightarrow \neg\,\mathrm{UCC}(A)}. \tag{219}$$

Because $s \in I_A$ entails $A \in \mathcal{S}_{\mathrm{phys}}(s)$, the same ontic counterinstance also contradicts CMA at that stage:

$$s \in I_A^+ \wedge \neg\,\mathrm{PhysReal}_A^+(s) \Longrightarrow \neg\,\mathrm{CMA}(s). \tag{220}$$

This is the logical adverse condition.

A flat record, an unchanged selected measurement, or failure to detect change is not yet that ontic counterinstance. Scientific rejection requires a bearer-complete stasis warrant, a nontrivial-history warrant, and a valid record-to-bearer inference. Those requirements are developed in Section 16.

Difficult stationary candidates

Systems described as stable, stationary, isolated, periodic, in equilibrium, or in a ground state are not dismissed by definition. Representative physical contexts for this audit include Casimir configurations, open quantum systems, stable open-system phases, and directly recorded quantum-jump dynamics [21, 22, 23, 24, 25].

For each candidate, the analysis must determine:

(1) the actual physical bearer;
(2) the identity criterion and nontrivial history;
(3) the variables represented by the stationary description;
(4) whether those variables are bearer-complete;
(5) the omitted physical relations and environmental conditions;
(6) and whether the evidence supports change, complete stasis, or an unresolved result.

A formal stationary model alone does not prove complete physical stasis. Conversely, CMA must not be defended by inventing an unspecified hidden mechanism whenever domain evidence is absent.

An unresolved physical route remains unresolved until the appropriate bearer-level model and evidence are supplied.

9. Ending, Physical Outcome, Transformation, and Successors

9.1 Functional failure and identity ending

Functional failure and identity ending are distinct physical classifications.

For a declared functional criterion κ,

$$\mathrm{FunctionalFailure}_{A,\kappa}(s) \not\Rightarrow \mathrm{IdentityEndingRealized}_{A}(s). \tag{221}$$

A bearer may lose a function, undergo severe damage, become clinically ill, cease normal operation, or enter a radically altered phase while its numerical identity remains physically realized.

Identity ends only when the physical conditions by which A remains that bearer cease to be realized under its declared identity criterion Γ_A^{id}.

The ending judgment is therefore bearer- and criterion-specific. The same physical occurrence may end one bearer classification while leaving another nested or constituent bearer continuing.

9.2 The actual ending boundary

Define the attained identity-ending boundary by

$$\boxed{\mathrm{End}_A(e) \iff e \in I_A \wedge \mathrm{IdentityEndingRealized}_A(e) \wedge \neg\exists u \in I_A\,(e \prec_C u)}. \tag{222}$$

The definition requires:

(i) realization of the bearer identity at e;
(ii) an actual identity-ending physical occurrence at e;
(iii) and absence of any later realization of that same numerical identity.

Greatestness within I_A alone does not physically produce an ending. The identity-ending occurrence remains an independent ontic component of the boundary classification.

Postulate 9.1 (Eventual Identity Ending)**.** Every physical bearer possesses one and only one ending member in its complete physical history:

$$\boxed{\forall A \in \mathcal{U}_{\mathrm{phys}}, \quad \exists! e \in I_A \ \mathrm{End}_A(e)}. \tag{223}$$

For the unique ending member, write

$$e_A := \iota e \in I_A \ \mathrm{End}_A(e), \qquad e_A = \max_{\prec_C} I_A. \tag{224}$$

This is an explicit complete-history physical commitment. It is not derived from the definition of time, strict ordering, CMA, UCC, Identity-Domain Convexity, or conservation principles.

A scientifically warranted bearer retaining the same numerical identity throughout the complete cosmic history without an ending member would contradict this postulate.

Finite non-observation of decay, model-relative stability, or a lower lifetime bound does not by itself establish such a complete-history counterexample.

9.3 Ending-occurrence exclusivity

The identity-ending predicate applies only at the unique ending boundary of the same numerical bearer:

$$\mathrm{IdentityEndingRealized}_A(s) \Longrightarrow [s \in I_A \wedge \neg\exists u \in I_A\,(s \prec_C u)]\,. \tag{225}$$

Together with Equation (222), this yields

$$\mathrm{IdentityEndingRealized}_A(s) \Longleftrightarrow \mathrm{End}_A(s). \tag{226}$$

Later severe alteration that does not terminate the declared identity must therefore be classified as change within the continuing history, not as an earlier or repeated identity ending.

9.4 Ending as positive physical realization

Identity ending is a subtype of positive bearer-specific physical realization:

$$\boxed{\mathrm{End}_A(e) \Longrightarrow \mathrm{PhysReal}^+_A(e)}. \tag{227}$$

Define

$$\mathrm{EndingReal}_A(e) \Longleftrightarrow \mathrm{End}_A(e) \wedge \mathrm{PhysReal}^+_A(e). \tag{228}$$

Under the classification bridge,

$$\mathrm{End}_A(e) \Longleftrightarrow \mathrm{EndingReal}_A(e). \tag{229}$$

The ending is not mere absence of A at later stages. It is the physical realization by which the identity ceases at its last identity member.

The stage does not cause the ending, and time does not terminate the bearer. The physical ground belongs to the bearer, its internal condition, its engagements, and the domain-specific transformation process.

9.5 One-stage bearer histories

A bearer may satisfy the one-stage identity-domain condition already fixed by Equation (161).

Under the formation and ending postulates,

$$f_A = e_A. \tag{230}$$

Its sole identity member may therefore realize both:

$$\text{IdentityFormationRealized}_A(f_A) \wedge \text{IdentityEndingRealized}_A(f_A). \tag{231}$$

These are two identity-relative classifications of the physical realization at one common stage:

(i) the bearer becomes actual there;
(ii) and no later realization of that same identity occurs.

The result does not imply that one physical identity exists before it forms or after it ends, and it does not require an intermediate stage.

9.6 Complete history and stage-relative completion

Define complete-history ending by

$$\text{HistoryComplete}(A) \iff \exists e \in I_A \ \text{End}_A(e). \tag{232}$$

Under Postulate 9.1,

$$\forall A \in \mathcal{U}_{\text{phys}}, \quad \text{HistoryComplete}(A). \tag{233}$$

This complete-domain statement does not imply that the ending has already been attained at an earlier reference stage.

Define

$$\begin{aligned} \text{CompletedBy}(A; a) \iff & a \in \mathcal{S}_C \\ & \wedge \exists e \in I_A \left[\text{End}_A(e) \wedge \text{AttainedBy}(e; a)\right]. \end{aligned} \tag{234}$$

If

$$a \in I_A \qquad \text{and} \qquad a \prec_C e_A,$$

then

$$\neg\, \text{CompletedBy}(A; a) \wedge \neg\, \text{AttainedBy}(e_A; a). \tag{235}$$

The complete history contains its actual ending member, while the stage-relative prefix at a has not yet attained it.

9.7 Ontic ending and epistemic localization

Where ending has been attained but its exact stage is not resolved, write

$$\text{EstimatedTerminationWindow}_{P,M}(A, W \mid a). \tag{236}$$

A warranted estimate satisfies

$$
\begin{aligned}
&\mathrm{CompletedBy}(A;a) \wedge \mathrm{EstimatedTerminationWindow}_{P,M}(A,W \mid a)\\
&\wedge \mathrm{Warrant}_{P,M}[\mathrm{EstimatedTerminationWindow}_{P,M}(A,W \mid a)]\\
&\quad\Longrightarrow \varnothing \neq W \subseteq \mathcal{S}_C^{\leq a} \wedge e_A \in W.
\end{aligned} \tag{237}
$$

The window is epistemic. It does not represent several endings or an ontologically extended identity-ending object.

A predicted future ending region is also distinct from an attained termination window:

$$
\mathrm{PredictedEndingWindow}_{P,M}(A,W \mid a) \not\Rightarrow \mathrm{CompletedBy}(A;a). \tag{238}
$$

9.8 Transformation process and identity boundary

A physical transformation may involve precursor interactions, reorganization, degradation, division, merger, collapse, reaction, exchange, or transient configurations across an extended physical process.

Let

$$
J_{\mathcal{P}\rightsquigarrow\mathcal{Q}} \subseteq \mathcal{S}_C \tag{239}
$$

denote a model- or evidence-relative process domain.

This domain may contain:

(a) late realizations of predecessor bearers;
(b) continuing physical contributors;
(c) intermediate configurations;
(d) independently qualified intermediate bearers;
(e) and early realizations of resulting bearers.

The possible extension of a process across several stages does not make the identity boundary itself plural.

Where the identity criteria justify one exact boundary e, productive predecessor identities end and successor identities form at that same common stage. This does not mean that every physical cause or preparatory process occurs instantaneously at e.

An intermediate configuration that satisfies an independent bearer criterion receives its own identity domain and physical history. A model state or temporary description does not become a bearer without that criterion.

Physical outcome and successor production

Identity ending and physical disappearance are different claims.

When A ends, its numerical identity ceases. Its physical material, energy, components, relations, emitted radiation, or other effects may continue in changed organization or in other bearers.

This continuing physical result is called the *physical outcome* of the ending.

A physical outcome is broader than a successor:

$$\text{PhysicalOutcomeOf}(A, e) \nRightarrow \exists B \in \mathcal{U}_{\text{phys}}\ \text{SuccAt}(A, B; e). \tag{240}$$

A successor exists only where a new bearer identity is physically produced from the ending predecessor under an actual production link.

This distinction preserves the broad physical fact that an ending does not become an untyped disappearance, while preventing every persisting constituent or affected system from being classified automatically as a successor.

9.9 Typed production specification

Let:

(i) $e \in \mathcal{S}_C$ be the declared transformation boundary;
(ii) $\varnothing \neq \mathcal{P} \subseteq \mathcal{U}_{\text{phys}}$ be the productive predecessor set;
(iii) $\varnothing \neq \mathcal{Q} \subseteq \mathcal{U}_{\text{phys}}$ be the successor set;
(iv) and $\mathcal{E} \subseteq \mathcal{P} \times \mathcal{Q}$ be the production-incidence relation.

Define the formal production-specification domain by

$$\begin{aligned}\Lambda_{\text{prod}} := \Big\{ \langle e, \mathcal{P}, \mathcal{Q}, \mathcal{E} \rangle \ \Big| \ & e \in \mathcal{S}_C \\ & \wedge \varnothing \neq \mathcal{P}, \mathcal{Q} \subseteq \mathcal{U}_{\text{phys}} \\ & \wedge \mathcal{P} \cap \mathcal{Q} = \varnothing \\ & \wedge \mathcal{E} \subseteq \mathcal{P} \times \mathcal{Q} \\ & \wedge \forall A \in \mathcal{P}\ \exists B \in \mathcal{Q}\ ((A, B) \in \mathcal{E}) \\ & \wedge \forall B \in \mathcal{Q}\ \exists A \in \mathcal{P}\ ((A, B) \in \mathcal{E}) \Big\}. \end{aligned} \tag{241}$$

The final two clauses make the incidence relation left-total and right-total over the declared productive sets. They do not require every predecessor to produce every successor.

Membership in Λ_{prod} establishes only formal admissibility:

$$\langle e, \mathcal{P}, \mathcal{Q}, \mathcal{E} \rangle \in \Lambda_{\text{prod}} \nRightarrow \text{PhysicalProductionLink}(\mathcal{P}, e, \mathcal{Q}; \mathcal{E}). \tag{242}$$

A well-typed tuple is not a physical production fact and not evidence for one.

9.10 The physical-production link

The primitive ontic relation

$$\text{PhysicalProductionLink}(\mathcal{P}, e, \mathcal{Q}; \mathcal{E}) \tag{243}$$

states that the declared productive linkage is physically realized.

Its type condition is

$$\text{PhysicalProductionLink}(\mathcal{P}, e, \mathcal{Q}; \mathcal{E}) \Longrightarrow \langle e, \mathcal{P}, \mathcal{Q}, \mathcal{E} \rangle \in \Lambda_{\text{prod}}. \tag{244}$$

The converse remains invalid.

The productive predecessor set contains only ending bearers physically incident to at least one successor in that linkage. It does not contain every bearer that influences the transformation or happens to end at the same stage.

A continuing contributor belongs instead to a physical-origin or outcome relation appropriate to its role.

9.11 Ontic transformation

Define a stage-resolved ontic transformation by

$$\boxed{\begin{aligned}\mathrm{TransformAt}^{\mathrm{ont}}(\mathcal{P}, e, \mathcal{Q}; \mathcal{E}) \iff\ & \mathrm{PhysicalProductionLink}(\mathcal{P}, e, \mathcal{Q}; \mathcal{E}) \\ & \wedge \forall A \in \mathcal{P}\ \ \mathrm{EndingReal}_A(e) \\ & \wedge \forall B \in \mathcal{Q}\ \ \mathrm{FormationReal}_B(e).\end{aligned}} \tag{245}$$

The relation states one physical transformation boundary at which:

(1) every declared productive predecessor ends;
(2) every declared successor forms;
(3) and the declared production incidences are physically actual.

No observation, record, model decision, or warrant is included in the ontic relation.

Scientific assertion is separately expressed by

$$\mathrm{TransformWarrant}_{P,M}\left[\mathrm{TransformAt}^{\mathrm{ont}}(\mathcal{P}, e, \mathcal{Q}; \mathcal{E})\right]. \tag{246}$$

Absence of present warrant does not entail absence of the ontic transformation. It does prevent warranted scientific assertion of its exact stage, bearer sets, or incidence relation.

9.12 Direct successorship

Define one actual direct production incidence by

$$\begin{aligned}\mathrm{DirectOutput}(A, B; \mathcal{P}, e, \mathcal{Q}, \mathcal{E}) \iff\ & \mathrm{TransformAt}^{\mathrm{ont}}(\mathcal{P}, e, \mathcal{Q}; \mathcal{E}) \\ & \wedge A \in \mathcal{P} \wedge B \in \mathcal{Q} \wedge (A, B) \in \mathcal{E}.\end{aligned} \tag{247}$$

The stage-indexed direct-successor relation is

$$\boxed{\mathrm{SuccAt}(A, B; e) \iff \exists \mathcal{P}, \mathcal{Q}, \mathcal{E}\ \ \mathrm{DirectOutput}(A, B; \mathcal{P}, e, \mathcal{Q}, \mathcal{E})}. \tag{248}$$

The unindexed direct-successor relation is

$$\mathrm{Succ}(A, B) \iff \exists e \in \mathcal{S}_C\ \ \mathrm{SuccAt}(A, B; e). \tag{249}$$

Therefore,

$$\text{SuccAt}(A, B; e) \Longrightarrow \text{End}_A(e) \wedge \text{AttainedFormation}_B(e) \wedge A \neq B. \tag{250}$$

Successorship does not transfer the numerical identity of A to B. The successor begins a new identity domain and its own physical history.

Similarity and material continuity do not establish a successor

The following are individually insufficient to establish direct successorship:

(i) physical similarity;
(ii) shared genetic or structural characteristics;
(iii) persistence of predecessor material;
(iv) spatial or observational succession;
(v) occupation of the same location;
(vi) inheritance of a name or function;
(vii) or mere formation after the predecessor ending.

Formally,

$$\begin{aligned} &\text{Similar}(A, B) \vee \text{SharedMaterial}(A, B) \vee \text{LaterFormationAfter}(B, A) \\ &\qquad \not\Rightarrow \text{Succ}(A, B). \end{aligned} \tag{251}$$

A successor attribution requires the physical-production link and the identity-boundary conditions.

One-to-one, one-to-many, many-to-one, and many-to-many transformation

The production specification permits:

(a) one predecessor and one successor;
(b) one predecessor and several successors;
(c) several productive predecessors and one successor;
(d) or several productive predecessors and several successors.

Thus particle decay, division, fission, fusion, merger, fragmentation, biological reproduction, stellar transformation, and composite reorganization are not forced into one universal one-to-one lineage pattern.

The incidence relation $\mathcal{E}$ records which predecessor is productively linked to which successor.

Co-membership in $\mathcal{P}$ and $\mathcal{Q}$ is not sufficient to assert every possible cross-link.

9.13 The successor-producing ending branch

Define

$$\boxed{\text{SuccessorProducingEnd}_A(e) \Longleftrightarrow \text{End}_A(e) \wedge \exists B \in \mathcal{U}_{\text{phys}}\ \text{SuccAt}(A, B; e)}. \tag{252}$$

The classification applies exactly when the ending bearer produces at least one new identity at the same ending boundary.

It does not identify:

(i) the number of successors;
(ii) a particular successor;
(iii) the complete successor set;
(iv) or the complete production-incidence relation.

Those stronger claims require their own ontic relations and warrants.

9.14 Contribution to already existing bearers

An ending may contribute physically to a bearer that existed before the ending boundary and continues afterward.

The primitive ontic relation has the signature

$$\mathrm{PhysicalOutcomeLink} : \mathcal{U}_{\mathrm{phys}} \times \mathcal{S}_C \times \mathcal{U}_{\mathrm{phys}} \longrightarrow \{\top, \bot\}. \tag{253}$$

The signature is a type declaration; it does not by itself assert that A ends at e, that B already exists there, or that B continues afterward. The proposition $\mathrm{PhysicalOutcomeLink}(A, e, B)$ records a physically realized contribution from A at e to B. In the derived relation below, the independent conjunct $\mathrm{End}_A(e)$ supplies the ending classification, while the remaining conjuncts supply the recipient conditions. Scientific attribution is separately expressed by

$$\mathrm{Warrant}_{P,M}[\mathrm{PhysicalOutcomeLink}(A, e, B)]\,,$$

and the warrant neither creates nor enters the ontic relation.

Define

$$\begin{aligned}\mathrm{ExtantOutcomeContinuation}_A(e) \iff{}& \mathrm{End}_A(e) \\ & \wedge \exists B \in \mathcal{U}_{\mathrm{phys}} \begin{bmatrix} B \neq A \wedge \mathrm{LaterInHistory}_B(e) \\ \wedge\ \mathrm{ContinuesAfter}(B, e) \\ \wedge\ \mathrm{PhysicalOutcomeLink}(A, e, B) \end{bmatrix}.\end{aligned} \tag{254}$$

The recipient B is not a newly formed successor at e. Its identity was already realized before the boundary and continues afterward.

This branch includes physically warranted cases such as:

(a) incorporation of material into an existing environmental system;
(b) transfer to an already existing organism, structure, atmosphere, ocean, soil, or stellar environment;
(c) dispersal that reorganizes continuing bearers;
(d) and other contributions not producing a new bearer identity.

9.15 Non-terminal Physical-Outcome Closure

Golden formulation: non-terminal physical-outcome closure

Principle 9.2 (Non-terminal Physical-Outcome Closure)**.** Every identity ending outside universal terminal ending possesses a physically continuous outcome through one or both outcome branches:

$$\boxed{\begin{aligned}&\mathrm{End}_A(e) \wedge \neg\,\mathrm{TerminalUniverse}(e)\\ &\quad \Longrightarrow \mathrm{SuccessorProducingEnd}_A(e) \vee \mathrm{ExtantOutcomeContinuation}_A(e).\end{aligned}} \tag{255}$$

The disjunction is inclusive. One ending may both:

(i) produce one or more new successor identities;
(ii) and contribute to one or more already existing bearers.

The principle does not follow merely from a conservation equation. It is an explicit governing physical commitment concerning the classified outcome of non-terminal identity ending.

The principle also does not imply that every ending produces a successor:

$$\mathrm{End}_A(e) \wedge \neg\,\mathrm{TerminalUniverse}(e) \not\Rightarrow \mathrm{SuccessorProducingEnd}_A(e). \tag{256}$$

The extant-recipient branch may satisfy closure without any new identity formation.

Outcome branches and authorial scope

The framework therefore uses *transformation* in two related but non-identical senses:

(1) the broad physical transformation through which the predecessor identity ends and a physical outcome follows;
(2) the narrower identity-producing transformation in which one or more successor identities form under $\mathrm{TransformAt}^{\mathrm{ont}}$.

Every non-terminal ending has a broad physical outcome under Principle 9.2.

Only identity-producing endings possess successors.

This distinction retains the intended claim that ending is physical transformation rather than disappearance, while preventing the term *successor* from being assigned where no new bearer identity has been established.

9.16 Identity distinction and bearer-tagged domains

Direct successorship entails

$$\mathrm{Succ}(A, B) \Longrightarrow A \neq B. \tag{257}$$

Distinct bearers may nevertheless have overlapping or even extensionally equal untagged stage sets.

The correct bearer-preserving representation is

$$\widetilde{I}_A := \{(A, s) \mid s \in I_A\}. \tag{258}$$

Then

$$A \neq B \Longrightarrow \widetilde{I}_A \cap \widetilde{I}_B = \varnothing. \tag{259}$$

Same-stage formation and ending therefore do not collapse predecessor and successor identities into one bearer.

9.17 Finite successor paths

Define the positive finite successor closure by

$$\begin{aligned} \mathrm{Succ}^+(A, B) \Longleftrightarrow \exists n \geq 1 \, \exists \sigma : \{0, \ldots, n\} \to \mathcal{U}_{\mathrm{phys}} \\ [\sigma(0) = A \wedge \sigma(n) = B \wedge \forall i < n \ \mathrm{Succ}(\sigma(i), \sigma(i+1))] \, . \end{aligned} \tag{260}$$

Strict indirect successorship requires at least two direct edges:

$$\begin{aligned} \mathrm{IndSucc}(A, B) \Longleftrightarrow \exists n \geq 2 \, \exists \sigma : \{0, \ldots, n\} \to \mathcal{U}_{\mathrm{phys}} \\ [\sigma(0) = A \wedge \sigma(n) = B \wedge \forall i < n \ \mathrm{Succ}(\sigma(i), \sigma(i+1))] \, . \end{aligned} \tag{261}$$

The relations classify finite lineage or production paths. They do not establish that every bearer has a finite predecessor chain reaching a bearer formed at cosmic origin.

9.18 Successor cycles, same-stage cascades, and terminal equivalence

A successor cycle is not excluded by the definition of time, CMA, or same-stage transformation alone.

Metatheoretic sequence convention.

Finite and countable bearer-sequence constructions in this subsection are carried out in the ordinary classical metatheory with countable dependent choice. This convention is used only to select a successor at each step of a serial relation. It is not a physical postulate about time, stages, or bearer production.

Constraint 9.3 (No infinite same-stage one-member cascade)**.** A physically admissible successor model excludes an infinite successor sequence—injective, non-injective, or periodic—composed wholly of one-stage bearers formed and ended at the same common stage:

$$\boxed{\begin{aligned} \mathrm{NoInfiniteSameStageCascade} \Longleftrightarrow \neg\exists s \in \mathcal{S}_C \ \exists \sigma : \mathbb{N} \to \mathcal{U}_{\mathrm{phys}} \\ \forall n \in \mathbb{N}, \left[I_{\sigma(n)} = \{s\} \wedge \mathrm{Succ}(\sigma(n), \sigma(n+1)) \right] . \end{aligned}} \tag{262}$$

The governing constraint is the assertion NoInfiniteSameStageCascade; the displayed biconditional fixes its exact formal content.

Proposition 9.4 (Successor acyclicity from cascade exclusion)**.** Under Postulates 6.1 and 9.1, Equation (248), Constraint 9.3, and Equations (54)–(56),

$$\boxed{\neg\exists A \in \mathcal{U}_{\text{phys}}\ \text{Succ}^{+}(A, A)}. \tag{263}$$

Proof. Assume a positive finite successor cycle. By Equation (260), choose $\eta(0), \ldots, \eta(m)$, where $m \geq 1$, $\eta(0) = \eta(m)$, and $\text{Succ}(\eta(i), \eta(i+1))$ for every $i < m$. For each edge choose $s_i \in \mathcal{S}_C$ satisfying $\text{SuccAt}(\eta(i), \eta(i+1); s_i)$, with indices read cyclically. Equation (248) and the transformation definitions make s_i the unique ending member of $\eta(i)$ and the unique formation member of $\eta(i+1)$. Hence each incoming edge stage is no later than the corresponding outgoing edge stage. A strict increase anywhere around the finite cycle would, by transitivity, make some stage earlier than itself. Therefore all edge stages are one stage s. Each bearer on the cycle then has the same unique least and greatest identity member s, so its identity domain is $\{s\}$. Periodically repeating the finite cycle defines a map $\sigma : \mathbb{N} \to \mathcal{U}_{\text{phys}}$ prohibited by Constraint 9.3. The assumed cycle is impossible.

The sequence in Constraint 9.3 is not required to be injective. Periodic repetition therefore converts every finite successor cycle into a prohibited same-stage sequence. The constraint also excludes an infinite acyclic chain of distinct one-stage bearers at one boundary. This is a coherence commitment of the successor package, not a theorem of temporal ordering alone.

9.19 Universal terminal ending

Define the greatest-cosmic-stage predicate by

$$\text{Greatest}_{\text{C}}(g) \iff g \in \mathcal{S}_C \wedge \neg\exists u \in \mathcal{S}_C\ (g \prec_C u). \tag{264}$$

Define universal terminal ending by

$$\boxed{\begin{aligned} \text{TerminalUniverse}(s_\Omega) \iff\ & \text{Greatest}_{\text{C}}(s_\Omega) \\ & \wedge \forall A \in \mathcal{S}_{\text{phys}}(s_\Omega), \quad \text{End}_A(s_\Omega) \\ & \wedge \neg\exists B \in \mathcal{U}_{\text{phys}}\ \text{AttainedFormation}_B(s_\Omega). \end{aligned}} \tag{265}$$

If this condition is realized, every bearer present there ends, no new bearer identity forms there, no later common cosmic stage exists, and no extant recipient continues beyond the boundary. Universal terminal ending is not postulated to occur.

Because no successor forms at a terminal stage,

$$\text{TerminalUniverse}(s_\Omega) \implies \forall A \in \mathcal{S}_{\text{phys}}(s_\Omega), \quad \neg\exists B \in \mathcal{U}_{\text{phys}}\ \text{SuccAt}(A, B; s_\Omega). \tag{266}$$

Proposition 9.5 (Greatest-stage–terminal-stage equivalence)**.** Under Postulate 9.1, Principle 9.2, Constraint 9.3, Equations (252) and (248), the strict-total-order conditions in Equations (54)–(56), and the metatheoretic sequence convention stated above, every $g \in \mathcal{S}_C$ satisfies

$$\boxed{\text{Greatest}_{\text{C}}(g) \iff \text{TerminalUniverse}(g)}. \tag{267}$$

Proof. The right-to-left direction follows directly from Equation (265). For the converse, assume $\text{Greatest}_{\text{C}}(g)$. If $A \in \mathcal{S}_{\text{phys}}(g)$, then $g \in I_A$. Postulate 9.1 supplies the unique greatest identity member $e_A \in I_A$. Since no cosmic stage is later than g, totality of $\prec_C$ forces $e_A = g$. Hence every bearer present at g ends there.

Suppose for contradiction that some bearer B_0 satisfies $\mathrm{AttainedFormation}_{B_0}(g)$. Greatestness and eventual ending give $I_{B_0} = \{g\}$ and $\mathrm{End}_{B_0}(g)$. Formation at g makes TerminalUniverse(g) false, while the extant-recipient branch is impossible there because ContinuesAfter(B, g) requires a stage later than g. Principle 9.2 therefore yields $\mathrm{SuccessorProducingEnd}_{B_0}(g)$, and Equation (252) supplies a direct successor B_1 at g. The stage-indexed successor semantics makes B_1 form at g; greatestness and eventual ending again give $I_{B_1} = \{g\}$. Countable dependent choice repeats this serial selection, producing an infinite same-stage sequence forbidden by Constraint 9.3. Thus no bearer forms at g. Together with the established ending of every bearer present there, Equation (265) yields TerminalUniverse(g).

The proposition does not assert that a greatest stage exists. It states only that greatestness and universal terminal ending are coextensive under the explicitly declared ending, closure, successor, cascade, order, and metatheoretic premises.

9.20 Probabilistic transformation models

A physical model may assign probabilities to alternative candidate outcomes:

$$\mathbb{P}_M\left(\lambda \mid \mathcal{C}\right), \qquad \lambda = \langle e, \mathcal{P}, \mathcal{Q}, \mathcal{E} \rangle \in \Lambda_{\mathrm{prod}}. \tag{268}$$

These probabilities are model outputs. They do not make every candidate outcome actual.

When one outcome is physically realized, the declared ontic production, transformation, and successor relations classify the actual production structure.

This permits stochastic decay, branching, collision outcomes, biological reproduction, and other probabilistically represented transformations without converting probability into ontic realization.

Application boundary

The ending-and-successor architecture applies only after the bearer and identity criteria have been fixed.

Examples include:

(i) death of an organism versus persistence of its constituents;
(ii) division of one cell into newly formed daughter-cell identities;
(iii) destruction of a city while materials and location persist;
(iv) radical biological regeneration where identity preservation must be decided independently;
(v) stellar collapse producing a compact remnant and ejecta;
(vi) galactic merger where predecessor and successor identity criteria differ from stellar criteria;
(vii) particle decay, fusion, or annihilation under the relevant physical bearer ontology.

The framework does not decide those identity judgments from the word *transformation* alone. Each application requires a bearer-valid identity criterion, physical linkage, and evidential warrant.

10. Spatial Realization, Place, and Physical Occupancy

10.1 The governing meaning of spatial realization

In V29/F9, *spatial realization* means the bearer-specific physical realization of location, spatial extent, orientation, occupancy, and spatial relation.

It does not mean that space or place is itself a physical bearer undergoing realization.

For a physical bearer A, spatial realization belongs to the physical description of A and to its relations with other physical bearers. It is therefore a bearer- and relation-dependent part of physical ontology, not an additional temporal foundation.

The governing dependency is

$$\boxed{\begin{aligned}\text{physical bearers} &\longrightarrow \text{spatial relations and configurations}\\ &\longrightarrow \text{location and occupancy attributions.}\end{aligned}} \tag{269}$$

The reverse dependency is invalid. A named location or spatial designation does not create a physical bearer, assign it an identity, or produce the physical systems occupying it.

Spatial reference bearers

A physical spatial attribution requires one or more declared physical references.

Let $R \in \mathcal{U}_{\text{phys}}$ be a reference bearer whose identity is realized at the stage under consideration. For $A \in \mathcal{U}_{\text{phys}}$, define the ontic spatial-configuration map

$$\Xi_{A|R} : I_A \cap I_R \longrightarrow \Omega^{\text{sp}}_{A|R}. \tag{270}$$

For $s \in I_A \cap I_R$,

$$\Xi_{A|R}(s)$$

denotes the actual spatial configuration of A relative to R at the common cosmic stage s.

Depending upon the bearer and the physical question, the configuration may include:

(i) relative position;
(ii) spatial extent;
(iii) orientation;
(iv) separation;
(v) containment or overlap;
(vi) distribution of components;
(vii) and other bearer-attributable spatial relations.

The reference bearer R is itself a changing physical system. Its use as a reference does not place it outside CMA or outside the common cosmic extension.

10.2 Physical reference and representational scheme

A physical reference bearer and a coordinate or mapping scheme are different types.

Let Σ be a declared spatial representation scheme, and let

$$\rho^{\mathrm{sp}}_{A|R,\Sigma} : \Omega^{\mathrm{sp}}_{A|R} \dashrightarrow \Lambda_{R,\Sigma} \tag{271}$$

be a partial representation map into a spatial-description codomain.

The represented spatial attribution is

$$\ell_{A|R,\Sigma}(s) := \rho^{\mathrm{sp}}_{A|R,\Sigma}\left(\Xi_{A|R}(s)\right). \tag{272}$$

The ontic configuration and its representation are not identical:

$$\Xi_{A|R}(s) \not\equiv \ell_{A|R,\Sigma}(s). \tag{273}$$

Coordinates, maps, grids, boundaries, addresses, and geographical names belong to representational or conventional schemes. They may represent physical spatial relations accurately under declared conditions, but they do not become the bearers or relations represented.

10.3 The governing meaning of place

A place does not denote an independent physical system merely by being a place.

It denotes a position, spatial range, or spatial relation in which physical systems are realized or through which their spatial relations are described.

Accordingly,

$$\boxed{\mathrm{PlaceDesignation}(L) \not\Rightarrow \mathrm{PhysicalSystem}(L)}. \tag{274}$$

The type of a declared place is

$$\mathrm{Type}(L) = \mathsf{SpatialDesignationOrRelation}, \tag{275}$$

unless the same name is explicitly being used to denote a physical bearer rather than the location itself.

A place may indicate:

(a) the position of one comparatively simple bearer;
(b) the spatial extent occupied by a composite bearer;
(c) a region containing many distinct and interacting systems;
(d) a spatial relation between two or more bearers;
(e) or a conventionally delimited geographical or operational domain.

The physical identity, state, realization, history, and causal efficacy remain attributable to the physical systems and factors involved, not to place in itself.

10.4 Bearer and place are not interchangeable

For a physical bearer A and a place designation L,

$$A \not\equiv L. \tag{276}$$

A bearer may occupy a place, leave it, return to it, extend across several designated regions, or cease while the place designation remains available.

Conversely, a place may be occupied successively or jointly by different bearers without acquiring their numerical identities.

Therefore,

$$\mathrm{SamePlace}(A, B; s) \not\Rightarrow A = B, \tag{277}$$

and

$$r, s \in I_A \not\Rightarrow \ell_{A|R,\Sigma}(r) = \ell_{A|R,\Sigma}(s). \tag{278}$$

for different realizations $r, s \in I_A$.

Numerical bearer identity and spatial location are independent classifications connected only through the bearer's physical history.

10.5 Physical occupancy

Let $L \subseteq \Lambda_{R,\Sigma}$ be a declared spatial designation, and let κ_{occ} be a stated occupancy criterion.

Define

$$\begin{aligned} \mathrm{Occupies}_{R,\Sigma}^{\kappa_{\mathrm{occ}}}(A, L; s) \iff s &\in I_A \cap I_R \\ &\wedge \kappa_{\mathrm{occ}} \left(\ell_{A|R,\Sigma}(s), L \right). \end{aligned} \tag{279}$$

The occupancy criterion must state what relation is intended. Depending upon the physical question, it may require:

(i) inclusion of a representative position within L;
(ii) intersection of the bearer's spatial extent with L;
(iii) complete containment within L;
(iv) partial occupation;
(v) component distribution across L;
(vi) or another declared physical-spatial relation.

A point-location criterion is not adequate for every extended or distributed bearer. Conversely, overlap with a region does not necessarily mean complete containment in it.

Occupancy is therefore a typed relation among:

(a) a physical bearer;
(b) a physical reference bearer;

(c) a common cosmic stage;
(d) a spatial representation scheme;
(e) a spatial designation;
(f) and an occupancy criterion.

It is not an intrinsic property of an independently existing object called place.

Ontic occupancy and scientific attribution

The physical spatial relation is ontic. Its coordinate, map, or geographical representation is model- and protocol-dependent.

Scientific assertion of occupancy requires an attribution bridge:

$$\text{OccupancyWarrant}_{P,M}\left[\text{Occupies}^{\kappa_{\text{occ}}}_{R,\Sigma}(A, L; s)\right]. \tag{280}$$

An observed signal, image, coordinate, or record does not establish occupancy without valid source attribution, reference identification, and spatial reconstruction.

Where the evidence does not resolve an exact spatial range, the scientifically admissible conclusion may be a spatial uncertainty region

$$\widehat{L}_{A;P,M} \subseteq \Lambda_{R,\Sigma}.$$

The uncertainty region belongs to epistemic representation. It does not mean that the bearer possesses several incompatible ontic locations in the ordinary bearer-level claim.

10.6 Location and spatial extent

A comparatively localized bearer may be represented by a selected position. An extended bearer requires a spatial extent or distribution.

Accordingly,

$$\text{RepresentativePosition}_{R,\Sigma}(A; s) \not\Rightarrow \text{CompleteSpatialExtent}_{R,\Sigma}(A; s). \tag{281}$$

The location of a centre, boundary point, detector response, or selected component does not automatically determine the spatial extent of the whole bearer.

This distinction is necessary for:

(i) organisms;
(ii) cities;
(iii) forests;
(iv) atmospheres;
(v) oceans;
(vi) fields and field–boundary systems under the adopted ontology;
(vii) distributed instruments;
(viii) stars;
(ix) galaxies;

(x) and other spatially extended systems.

The bearer criterion and spatial-attribution rule must specify which physical components and relations define the relevant extent.

10.7 Spatial overlap and bearer distinction

Different physical bearers may occupy overlapping spatial regions.

For example, a component may occupy part of the same region as the composite bearer of which it is a part. An organism, its organs, cells, molecules, and surrounding exchanged material may be spatially nested without becoming one numerical bearer.

Therefore,

$$\mathrm{SpatialOverlap}_{R,\Sigma}(A,B;s) \not\Rightarrow A = B. \tag{282}$$

Likewise,

$$\mathrm{PartOf}(B,A;s) \not\Rightarrow \mathrm{SameBearer}(A,B). \tag{283}$$

Bearer distinction is governed by identity criteria, not by non-overlapping occupancy.

The same spatial region may therefore contain nested, interacting, and partially overlapping bearer histories at one common cosmic stage.

Place names and ambiguous referents

Ordinary language often uses one name for both a spatial location and a physical system associated with that location.

A place name may refer to:

(a) a geographical region;
(b) a city as a complex physical bearer or organized system of systems;
(c) the buildings, inhabitants, infrastructure, and environmental systems occupying the region;
(d) an administrative classification;
(e) or the historical remains of a bearer that no longer exists.

These referents must not be conflated.

Where C denotes a city bearer and L_C denotes its associated geographical designation,

$$C \not\equiv L_C. \tag{284}$$

The city may alter its occupied extent while its identity persists. Its physical identity may also end while the geographical region, materials, ruins, soil, water, and later occupants continue.

The persistence of the location does not establish persistence of the city identity.

10.8 Destroyed cities and physical remains

Suppose a city bearer C ends at e_C. Its buildings, fragments, roads, buried structures, dispersed materials, records, and modified environment may persist or contribute to other bearers.

Then

$$\mathrm{End}_C(e_C) \not\Rightarrow \mathrm{AllPhysicalContentAbsentAfter}(e_C). \tag{285}$$

However,

$$\mathrm{RuinsRemainAt}(L_C; s) \not\Rightarrow s \in I_C. \tag{286}$$

Ruins are later physical systems or parts of continuing systems, depending upon the adopted bearer criteria. They are not later states of the ended city merely because they occupy the associated geographical region or preserve records of its history.

Likewise, archaeological discovery at a later stage does not identify the discovery stage with the city-ending stage:

$$\mathrm{RuinsDiscoveredAt}_{P,M}(C; d) \not\Rightarrow d = e_C. \tag{287}$$

The discovery is a later interaction and record-producing event in the histories of the remains, investigators, instruments, and environment.

10.9 Unoccupied and reoccupied places

A spatial designation may be unoccupied relative to a declared bearer class:

$$\neg\exists A \in \mathcal{B}\ \ \mathrm{Occupies}^{\kappa}_{R,\Sigma}(A, L; s), \tag{288}$$

where $\mathcal{B} \subseteq \mathcal{U}_{\mathrm{phys}}$ is the investigated bearer class.

This statement does not make L an empty physical bearer. It states only that no member of the declared class satisfies the occupancy relation under the stated criterion.

Later reoccupation by another bearer does not restore an earlier bearer identity:

$$\begin{aligned} &\mathrm{Occupies}_{R,\Sigma}(A, L; r) \wedge \mathrm{Occupies}_{R,\Sigma}(B, L; s) \wedge r \prec_C s \\ &\quad \not\Rightarrow A = B. \end{aligned} \tag{289}$$

Return to the same designated place is spatial recurrence, not return to an earlier cosmic stage.

10.10 Place has no independent bearer history

Because place is not introduced as an independent bearer, V29/F9 does not assign it a bearer history of the form

$$\mathcal{H}_L = (I_L, \prec_C |_{I_L}, X_L)$$

merely because L is a spatial designation.

What may be studied instead is:

(i) the history of bearers occupying L;
(ii) the history of the physical reference system used to define L;
(iii) changes in spatial relations among bearers;
(iv) changes in a composite physical system conventionally named after the place;
(v) and the history of records and maps representing the region.

Thus, an ordinary statement such as "the place changed" must be resolved into a physically typed claim.

It may mean that:

(a) the occupying systems changed;
(b) the population of bearers changed;
(c) the spatial boundaries used in the designation changed;
(d) the reference systems changed;
(e) or the spatial relations among physical systems changed.

The place itself is not assigned an unanalysed change predicate.

No independent causal action of place

A place does not cause physical change merely by being a place.

Where location-dependent physical effects occur, the causal explanation must identify the relevant physical systems, factors, relations, and conditions.

Accordingly,

$$\mathrm{LocatedAt}(A, L; s) \not\Rightarrow \mathrm{PlaceItselfCausesChange}(L, A; s). \tag{290}$$

A statement that an environment, laboratory, altitude, ocean, stellar region, or other location affects a bearer must be analysed into its physical grounds, such as interacting systems, radiation, pressure, temperature, fields, chemical conditions, gravity under the adopted physical model, or other specified factors.

The location may help identify where those conditions are realized. It does not replace them as a causal explanation.

Spatial separation and common-stage unity

For $A, B \in \mathcal{S}_{\mathrm{phys}}(s)$, spatial separation does not divide the common cosmic stage; the governing co-presence result is Equation (118).

Distance may affect:

(i) causal interaction;
(ii) signal propagation;
(iii) accessibility;
(iv) synchronization procedures;

(v) record formation;
(vi) and scientific reconstruction.

It does not affect whether the two then-existing bearers belong to the same common cosmic stage.

Thus,

$$\text{DifferentLocations}(A, B; s) \nRightarrow \text{DifferentTimes}(A, B). \tag{291}$$

The unity is temporal and cosmic. The spatial multiplicity belongs to the physical configurations of the bearers.

10.11 Spatial configuration is not cosmic-stage position

A bearer's spatial position and its position in the cosmic ordering are different types.

For $s \in I_A$,

$$\ell_{A|R,\Sigma}(s) \not\equiv s. \tag{292}$$

A change in spatial attribution does not move the bearer from one time to another. It is a bearer-specific physical change realized at ordered common cosmic stages.

Likewise, equality of spatial attribution at two stages does not identify those stages:

$$\ell_{A|R,\Sigma}(r) = \ell_{A|R,\Sigma}(s) \nRightarrow r = s. \tag{293}$$

The bearer may remain in, or return to, the same represented location while the cosmic ordering remains irreversible.

Preparation for the definition of motion

Physical motion requires comparison of the spatial realization of one bearer under a continuing and adequately specified reference.

The dependency is

$$\begin{gathered} A, R \in \mathcal{U}_{\text{phys}} \\ \Downarrow \\ \Xi_{A|R}(r), \Xi_{A|R}(s) \\ \Downarrow \\ \text{valid spatial comparison under identity continuity} \\ \Downarrow \\ \text{motion, rest, return, or spatial recurrence classification.} \end{gathered} \tag{294}$$

A change of coordinates alone does not establish physical motion, and a change of physical reference may alter the reported spatial description without changing the underlying relation being investigated.

The complete definition of motion is therefore deferred to Section 11, after the required bearer, reference, and spatial-attribution types have been fixed here.

11. Motion, Migration, Local Cycles, and Irreversible Succession

11.1 The governing meaning of physical motion

Physical motion is bearer-specific change in spatial realization or spatial relation relative to one or more declared physical references.

A bearer does not move inside time, through time, from one time to another, or between temporal containers. Time denotes the universal ordering and succession within which the bearer's spatially different states are realized.

The governing statement is:

Motion is physical change in the spatial realization or spatial relations of a bearer relative to declared physical references, such that different spatial configurations are realized at ordered common cosmic stages.

Therefore,

$$\mathrm{PhysicalMotion}(A) \not\Rightarrow \mathrm{MovementThroughTime}(A). \tag{295}$$

The bearer changes its position, orientation, extent, distribution, or spatial relation. It does not change its temporal domain or acquire a private time.

Spatial difference between ordered bearer states

Let A be a physical bearer, R a physical reference bearer, and $\Gamma^{\mathrm{sp}}_{A|R}$ a declared criterion for comparing their spatial configurations.

For $r, s \in I_A \cap I_R$, define a net spatial-difference relation by

$$\begin{aligned} &\mathrm{NetSpatialDifference}_{A|R,\Gamma^{\mathrm{sp}}}(r,s) \\ &\quad\Longleftrightarrow r \prec_C s \wedge \mathrm{IdCont}_A(r,s) \wedge \mathrm{IdCont}_R(r,s) \\ &\qquad \wedge\, \Xi_{A|R}(r) \not\equiv_{\Gamma^{\mathrm{sp}}_{A|R}} \Xi_{A|R}(s). \end{aligned} \tag{296}$$

The relation states that the same bearer A, compared under a continuing reference R, possesses non-equivalent spatial configurations at two ordered stages.

It does not assert:

- (i) an immediate next stage;
- (ii) a continuous geometrical trajectory of a stipulated mathematical type;
- (iii) a metric distance;
- (iv) a velocity;
- (v) or one uniquely localized stage at which the entire displacement occurred.

Those stronger claims require additional physical and modelling structure.

Motion over a bearer-history domain

Let

$$J \subseteq I_A \cap I_R$$

be a nonempty ordered investigation domain.

Define motion over J by

$$\mathrm{MotionOver}_{A|R,\Gamma^{\mathrm{sp}}}(J) \Longleftrightarrow \exists r, s \in J \ \ \mathrm{NetSpatialDifference}_{A|R,\Gamma^{\mathrm{sp}}}(r, s). \tag{297}$$

This definition supplies an ontic spatial-change witness within J. It does not require every member of J to be separately represented or observed.

If the endpoints of a complete cycle are spatially equivalent, motion may still be established through intermediate members of J. Endpoint equality alone is therefore not sufficient to classify the entire history as rest.

Motion as bearer-specific physical change

A warranted spatial change in the same persisting bearer is a form of bearer-specific physical change.

For $r, s \in I_A \cap I_R$,

$$\begin{aligned} &\mathrm{NetSpatialDifference}_{A|R,\Gamma^{\mathrm{sp}}}(r, s) \\ &\quad \Longrightarrow \mathrm{SpatialChangeWithinHistory}_A(r, s). \end{aligned} \tag{298}$$

The physical realization belongs to the moving bearer and to the physical relations in which it participates. It is not produced by the cosmic ordering.

The common stages supply the fixed earlier–later order of the spatial configurations. They do not push, transport, or guide the bearer.

11.2 Motion is relative to physical references

A motion statement is incomplete unless its reference is declared.

For two reference bearers R_1 and R_2,

$$\mathrm{MotionOver}_{A|R_1,\Gamma_1}(J) \not\Rightarrow \mathrm{MotionOver}_{A|R_2,\Gamma_2}(J). \tag{299}$$

A bearer may be at rest relative to one system while moving relative to another. A sample may remain fixed relative to a laboratory table while participating in the rotation of Earth, Earth's orbital motion, and wider motions relative to other physical references.

Reference dependence concerns the spatial description. It does not imply that each reference possesses a different cosmic time.

11.3 Relative rest

Define relative rest over J by

$$\mathrm{Rest}_{A|R,\Gamma^{\mathrm{sp}}}(J) \iff \forall r, s \in J, \quad \Xi_{A|R}(r) \equiv_{\Gamma^{\mathrm{sp}}_{A|R}} \Xi_{A|R}(s). \tag{300}$$

Relative rest states stability of the declared spatial relation under the selected criterion.

It does not entail complete physical stasis:

$$\mathrm{Rest}_{A|R,\Gamma^{\mathrm{sp}}}(J) \nRightarrow \mathrm{CompletePhysicalStasis}(A; J). \tag{301}$$

The bearer may undergo internal, thermal, molecular, chemical, electromagnetic, biological, structural, or relational realizations while maintaining the selected spatial relation.

Nor does relative rest exempt either A or R from CMA.

Coordinate change and physical motion

A coordinate change and a physical change of spatial relation are different propositions.

Let

$$\ell_{A|R,\Sigma_1}(s) \qquad \text{and} \qquad \ell_{A|R,\Sigma_2}(s)$$

be two representations of one ontic spatial configuration under different schemes.

Then

$$\ell_{A|R,\Sigma_1}(s) \neq \ell_{A|R,\Sigma_2}(s) \nRightarrow \mathrm{PhysicalMotionAt}(A; s). \tag{302}$$

A change in coordinate values may result from changing the chart, origin, orientation, scale, or reference convention.

Conversely, equality of selected coordinate values does not establish absence of all spatial change unless the representation and comparison bridge are adequate for the bearer and claim.

Physical motion is attributed through the underlying bearer relations, not through numerical coordinate difference alone.

Change of reference

If the reference bearer or reference scheme changes between two records, a reported positional difference may reflect:

(a) motion of A;
(b) motion or transformation of the reference bearer;
(c) change of representation;
(d) or a combination of these.

A valid motion inference therefore requires continuity or controlled replacement of the reference specification.

Schematically,

$$\begin{aligned} &\ell_{A|R_1,\Sigma_1}(r) \neq \ell_{A|R_2,\Sigma_2}(s) \\ &\qquad \not\Rightarrow \mathrm{NetSpatialDifference}_{A|R,\Gamma^{\mathrm{sp}}}(r,s) \end{aligned} \tag{303}$$

without a validated transformation between the two reference descriptions.

11.4 Motion and bearer identity

Change of place does not by itself end bearer identity:

$$\mathrm{MotionOver}_{A|R,\Gamma^{\mathrm{sp}}}(J) \not\Rightarrow \mathrm{IdentityEndingWithin}(A;J). \tag{304}$$

A bearer may move through many regions while preserving its numerical identity.

Conversely, two records or represented locations indicating the same place do not by themselves warrant persistence of the same numerical bearer identity:

$$\mathrm{SameRepresentedLocation}_{P,M}(r_1,r_2) \not\Rightarrow \mathrm{Warrant}_{P,M}\left[\mathrm{IdCont}_A(s_1,s_2)\right]. \tag{305}$$

The record-to-stage and bearer-attribution bridges must be established before the identity-continuation proposition can be scientifically asserted.

Within an already established domain $J \subseteq I_A$, identity continuation follows from the bearer attribution and Identity-Domain Convexity, not from spatial rest itself.

A system may transform or end while much of its material remains in approximately the same spatial region.

Identity is governed by the bearer criterion, not by displacement, absence of displacement, or equality of represented locations alone.

11.5 Motion within composite and distributed bearers

Motion may occur at several bearer levels.

A constituent B may move relative to composite bearer A while the composite remains at rest relative to an external reference R:

$$\mathrm{MotionOver}_{B|A}(J) \wedge \mathrm{Rest}_{A|R}(J). \tag{306}$$

Likewise, a composite bearer may move while some internal relations remain stable.

The relevant bearer and reference must therefore be stated before motion is attributed.

Motion of one component may constitute part of the physical change of the composite, but it does not automatically end the identity of either the component or the whole.

11.6 Spatial path

A spatial path is an ordered representation of successive spatial configurations of a bearer under a declared reference and model.

For an ordered bearer subdomain $J \subseteq I_A \cap I_R$, define the ontic path restriction by

$$\Xi_{A|R}|_J. \tag{307}$$

A model may represent that restriction by

$$\widehat{\gamma}_{A|R;P,M} : \Lambda_{P,M} \longrightarrow \Lambda_{R,\Sigma}, \tag{308}$$

where $\Lambda_{P,M}$ is a declared operational parameter domain.

The reconstructed path is not identical with the complete ontic path:

$$\widehat{\gamma}_{A|R;P,M} \not\equiv \Xi_{A|R}|_J. \tag{309}$$

The model may interpolate between records, estimate trajectories, or assign uncertainty regions. Those operations do not enumerate the common cosmic stages or convert the operational parameter into time as defined by ITOF.

11.7 Velocity and rate restraint

A velocity is a model- and protocol-relative rate of spatial change against a declared numerical parameter or clock output.

It is not a rate of time.

For a coordinate representation $\boldsymbol{x}_{A|R}$ and operational parameter λ,

$$\boldsymbol{v}_{A|R} = \frac{d\boldsymbol{x}_{A|R}}{d\lambda} \tag{310}$$

belongs to the physical-spatial model of A, the reference R, and the parameter λ.

Therefore,

$$\boldsymbol{v}_{A|R} \not\Rightarrow \mathrm{RateOfCosmicSuccession}\,. \tag{311}$$

The quantitative role of clock records and operational intervals is developed in Section 12.

Migration

Migration is an extended bearer-history classification involving organized spatial change across a declared spatial domain.

For an organism or other bearer A, migration requires at least:

(i) persistence of the same bearer identity;
(ii) ordered spatial realizations relative to declared references;
(iii) departure from one region or spatial relation;
(iv) traversal or displacement;
(v) and arrival at another region or a later return.

Define schematically

$$\begin{aligned} \text{Migration}_{A|R}(J) \implies & \text{IdCont}_A(\min J, \max J) \\ & \wedge \text{MotionOver}_{A|R}(J). \end{aligned} \tag{312}$$

The implication states necessary conditions, not a complete biological definition. Domain-specific migration may additionally involve seasonality, navigation, feeding, reproduction, population behaviour, or environmental response.

Migration is physical change in the bearer's spatial history. It is not movement from one time into another.

11.8 Return to a previous place

Suppose A occupies a declared place L at stages r and t, with motion through other spatial configurations between them:

$$\begin{aligned} & r \prec_C t \wedge \text{Occupies}(A, L; r) \wedge \text{Occupies}(A, L; t) \\ & \quad \wedge \text{MotionOver}_{A|R}(J_{r,t}). \end{aligned} \tag{313}$$

Then the later occupancy is a return to a spatial designation, not a return to the earlier cosmic stage:

$$\boxed{\text{ReturnToPlace}(A, L; r, t) \implies r \neq t \wedge r \prec_C t}. \tag{314}$$

The place may be similar, but:

(a) the bearer has undergone intervening physical realizations;
(b) other systems occupying or affecting the place may have changed;
(c) the reference bearer and environment may have changed;
(d) and the universal cosmic succession has continued irreversibly.

Spatial return is therefore recurrence in a declared spatial relation.

Migratory birds and bearer discipline

Migratory birds provide a clear multilevel example.

For one individual bird B, departure, travel, stopover, and return may belong to one continuing physical history

$$\mathcal{H}_B.$$

The bird's changing position does not create different times at different locations.

A flock, population, species sample, or migratory lineage may also be studied as a different bearer under its own identity criterion. The history of the individual must not be transferred automatically to the population, and the population history must not be treated as the numerical history of one individual.

If a later generation reaches a region occupied by an earlier generation, then

$$\text{SameMigratoryRegion}(B_1, B_2) \not\Rightarrow B_1 = B_2. \tag{315}$$

The later generation possesses its own bearer histories within the same cosmic ordering.

11.9 Rotation

Rotation is change in orientation or angular spatial relation relative to a declared physical reference.

It is a form of physical motion:

$$\text{RotationOver}_{A|R}(J) \Longrightarrow \text{MotionOver}_{A|R}(J). \tag{316}$$

A body may return to an orientation equivalent to an earlier orientation under a declared criterion:

$$\Xi^{\text{orient}}_{A|R}(r) \equiv_{\Gamma_{\text{rot}}} \Xi^{\text{orient}}_{A|R}(t), \qquad r \prec_C t. \tag{317}$$

The repeated orientation does not identify the stages. The intervening rotation remains part of the later physical history.

Orbital motion

Orbital motion is ordered change in the spatial relation between a bearer and a declared reference or system of references.

A later orbital position may be equivalent to an earlier position under an adopted orbital criterion:

$$\Xi^{\text{orb}}_{A|R}(r) \equiv_{\Gamma_{\text{orb}}} \Xi^{\text{orb}}_{A|R}(t), \qquad r \prec_C t. \tag{318}$$

This is spatial recurrence, not temporal recurrence.

An orbit may also evolve, precess, decay, or be perturbed. Equality under one selected positional criterion does not establish equality of the complete bearer state, orbital configuration, environment, or physical history.

11.10 Local cycles

A local cycle is recurrence of a selected physical condition in one or more local bearers.

Examples include:

(i) rotation;
(ii) orbital recurrence;
(iii) periodic biological activity;
(iv) migration;
(v) tidal or environmental cycles;
(vi) seasonal conditions;
(vii) and local alternation of illumination and darkness.

For a local classification Q_A,

$$Q_A(r) \equiv_{\Gamma_Q} Q_A(t) \wedge r \prec_C t \tag{319}$$

states recurrence of the selected condition.

It does not imply:

$$r = t, \qquad t \prec_C r, \qquad \text{or} \qquad X_A(r) = X_A(t). \tag{320}$$

A local cycle is physically ordered and historically cumulative even when its selected pattern repeats.

11.11 Night and day

Night and day are local physical illumination conditions realized in terrestrial regions and systems.

Their occurrence depends upon the spatial relations among the Earth, the Sun, the terrestrial region, atmospheric and environmental systems, and the relevant illumination path.

Let L be a terrestrial region and define a local illumination classification

$$\mathrm{IlluminationState}_L(s) \in \{\mathsf{Day}, \mathsf{Night}, \mathsf{Intermediate}, \mathsf{Obscured}\}. \tag{321}$$

The classification belongs to the physical conditions of the region and the systems occupying it. It is not a state of time.

Therefore,

$$\mathrm{DayAt}(L_1; s) \wedge \mathrm{NightAt}(L_2; s) \nRightarrow \mathrm{DifferentTimes}(L_1, L_2). \tag{322}$$

Different terrestrial regions may realize different illumination conditions at the same common cosmic stage.

Night–day recurrence

For one region L, the sequence

$$\mathsf{Night}_1 \longrightarrow \mathsf{Day} \longrightarrow \mathsf{Night}_2$$

represents ordered physical changes in illumination and spatial relations.

Even where

$$\mathrm{IlluminationState}_L(r) = \mathrm{IlluminationState}_L(t) = \mathsf{Night}, \qquad r \prec_C t, \tag{323}$$

the later night is not the earlier night and does not restore the earlier cosmic stage.

The physical bearers, atmospheric conditions, local environment, observers, instruments, and wider universe have continued their bearer-specific realizations throughout the intervening succession.

Local dates and civil divisions

Human societies divide recurring terrestrial and astronomical processes into days, dates, seasons, and local schedules.

These classifications organize physical records and social activity. They do not divide the common cosmic extension.

Different local date labels may apply at the same common cosmic stage:

$$\mathrm{LocalDate}_{Z_1}(s) \neq \mathrm{LocalDate}_{Z_2}(s) \not\Rightarrow \mathrm{DifferentCosmicTimes}(Z_1, Z_2). \tag{324}$$

The zones and date conventions are representational and operational systems based upon terrestrial motion, standardized clocks, and adopted rules.

Their detailed construction belongs to Section 12.

11.12 Irreversible succession through recurring motion

Motion may be reversible under a selected spatial description. A bearer may move outward and later inward, rotate clockwise and later counterclockwise, or return along a previous route.

Such reversal of spatial direction does not reverse cosmic succession.

For spatial configurations q_1, q_2,

$$\begin{aligned} &\Xi_{A|R}(r) = q_1, \quad \Xi_{A|R}(s) = q_2, \quad \Xi_{A|R}(t) = q_1, \\ &r \prec_C s \prec_C t \end{aligned} \tag{325}$$

is compatible with return to q_1, but it entails

$$r \neq t \wedge \neg(t \prec_C r). \tag{326}$$

Physical reversibility in selected variables and irreversibility of the cosmic order are therefore different propositions.

11.13 Motion records and exact-stage restraint

Motion is ordinarily studied through images, tracks, detector records, navigation data, clock outputs, or other physical records.

A valid record sequence may warrant a trajectory or displacement under a declared model:

$$\mathrm{ValidatedMotionRecords}_{P,M}(A, \mathcal{R}) \Longrightarrow \mathrm{TrajectoryWarrant}_{P,M}\left[\widehat{\gamma}_{A|R;P,M}\right]. \tag{327}$$

This warrant does not supply a canonical one-to-one map from every point on the reconstructed trajectory to one exact common cosmic stage.

Nor does the first record showing displacement identify the first stage at which the relevant spatial change began:

$$\mathrm{FirstDetectedDisplacement}_{P,M}(A; r_D) \not\Rightarrow \mathrm{FirstMotionStage}(A; r_D). \tag{328}$$

The record, detector, reference system, and moving bearer all possess their own physical histories.

12. Clocks, Operational Intervals, and Local Conventions

12.1 The governing status of a clock

A clock is a physical bearer selected because one or more of its repeatable, stable, or modelled physical processes can be converted into ordered records and standardized numerical readings.

Accordingly,

$$\mathrm{Clock}(C) \Longrightarrow \mathrm{PhysicalSystem}(C). \tag{329}$$

A clock may be:

(i) an atomic or molecular system;
(ii) an oscillator or resonator;
(iii) a rotating or orbiting physical bearer;
(iv) a decaying system or ensemble;
(v) an electronic circuit;
(vi) a mechanical device;
(vii) or a composite apparatus integrating several physical processes.

The clock remains subject to the same bearer ontology as every other physical system. It possesses:

$$\mathcal{H}_C = (I_C, \prec_C|_{I_C}, X_C)\,, \tag{330}$$

and, under CMA,

$$C \in \mathcal{S}_{\mathrm{phys}}(s) \Longrightarrow \mathrm{PhysReal}^{+}_{C}(s). \tag{331}$$

Its selection as a standard or reference does not place it outside the common cosmic extension and does not exempt it from physical change.

12.2 Clocks do not measure time as defined by ITOF

The canonical temporal denotation is

$$T_{\mathrm{ITOF}} = (\mathcal{S}_C, \prec_C)\,.$$

A clock does not directly detect, contain, transport, or measure this ordered domain.

It undergoes its own physical realizations and produces records from those realizations.

Therefore,

$$\boxed{\mathrm{ClockOutput} \not\equiv T_{\mathrm{ITOF}}} \tag{332}$$

and

$$\boxed{\text{ClockRecord} \not\equiv \text{CommonCosmicStage}\,.} \tag{333}$$

The usefulness of clocks is not denied. Clocks provide standardized operational means for:

(a) ordering records;
(b) comparing physical processes;
(c) coordinating activities;
(d) navigation and communication;
(e) defining schedules and dates;
(f) and constructing quantitative physical models.

These functions do not transfer the ontological type of time to the clock, its process, its record, or its numerical output.

12.3 Clock process and record production

Let $J \subseteq I_C$ be a declared clock-history domain.

Let

$$\mathfrak{H}^{\text{phys}}_{C,J}$$

be the domain of admissible physical clock-history segments over J, and let

$$\Theta_{C,P}$$

contain the physical and protocol conditions relevant to clock operation.

These conditions may include:

(i) physical environment;
(ii) temperature and pressure;
(iii) electromagnetic or other control fields;
(iv) power supply;
(v) motion relative to declared references;
(vi) gravitational conditions under the adopted physical model;
(vii) coupling and isolation;
(viii) device condition and ageing;
(ix) interrogation procedure;
(x) and record convention.

Define clock-record production by

$$\mathcal{R}_{C,P} : \mathfrak{H}^{\text{phys}}_{C,J} \times \Theta_{C,P} \longrightarrow \mathfrak{R}_{C,P}, \tag{334}$$

with

$$r_C = \mathcal{R}_{C,P}\left(h_{C,J}, \theta_{C,P}\right). \tag{335}$$

Here:

(a) $h_{C,J}$ is a physical history segment of the clock;
(b) $\theta_{C,P}$ states the declared operating and protocol conditions;
(c) r_C is a physically realized clock record;
(d) and $\mathfrak{R}_{C,P}$ is the protocol-specific record domain.

The history-segment input is necessary because accumulation, oscillation, counting, memory, interrogation, and readout may depend upon more than one isolated clock state.

12.4 Numerical clock reading

Under protocol P, define a reading map

$$N_{C,P} : \mathfrak{R}_{C,P} \longrightarrow \mathbb{R}_P, \tag{336}$$

where

$$n_C = N_{C,P}(r_C).$$

The codomain $\mathbb{R}_P$ is the numerical reporting scale adopted by the protocol.

The mapping may include:

(i) cycle counting;
(ii) scale and unit selection;
(iii) interpolation;
(iv) calibration;
(v) correction;
(vi) rounding;
(vii) and display or transmission rules.

The resulting type boundary is

$$\boxed{n_C \in \mathbb{R}_P, \qquad n_C \not\equiv T_{\mathrm{ITOF}}, \qquad r_C \not\equiv s \quad (s \in \mathcal{S}_C).} \tag{337}$$

A numerical reading is a result of a physical history and a declared mapping. It is not a cosmic stage and is not time.

Clocks do not count cosmic stages

The cosmic-stage domain is not assumed to be:

(a) discrete;
(b) countable;
(c) equally spaced;
(d) metrically separated;

(e) or individually accessible to instruments.

A clock counts or measures a selected feature of its own physical process. It does not count the members of $\mathcal{S}_C$.

Therefore,

$$N_{C,P}(r_C) = n \not\Rightarrow \text{NumberOfCosmicStagesAttained} = n. \tag{338}$$

A clock completing more cycles than another clock does not mean that it has passed through more time or more cosmic stages.

Both clocks remain members of the same common cosmic succession wherever their identities are realized.

12.5 Operational ordering of records

For records r_1, r_2, define

$$r_1 \lhd_P r_2 \tag{339}$$

to mean that protocol P places r_1 before r_2.

The grounds may include:

(i) detector architecture;
(ii) storage order;
(iii) causal or transmission sequence;
(iv) sequential clock counts;
(v) source attribution;
(vi) or another validated operational rule.

The operational relation is not identical with the cosmic ordering:

$$\lhd_P \not\equiv \prec_C . \tag{340}$$

A valid physical and evidential bridge may warrant consistency between a particular record order and the order of attributed physical occurrences. The protocol does not create the cosmic order.

12.6 Operational interval

For clock records

$$r_{C,1} \lhd_P r_{C,2},$$

define the numerical operational interval

$$\boxed{\Delta N_{C,P} := N_{C,P}(r_{C,2}) - N_{C,P}(r_{C,1}).} \tag{341}$$

The result is a difference in the clock's numerical reporting scale.

It is not:

(a) an amount of cosmic extension;
(b) a number of common cosmic stages;
(c) a quantity possessed by time;
(d) or a physical substance located between two occurrences.

Thus,

$$\Delta N_{C,P} \not\equiv \mathrm{TemporalMagnitudeOf}\left(\mathcal{S}_C, \prec_C\right). \tag{342}$$

The interval remains scientifically meaningful because its protocol, unit, calibration, and physical production conditions are declared.

Duration language

Ordinary and scientific language may call $\Delta N_{C,P}$ a duration or elapsed time.

Within the formal ontology of ITOF, that expression is interpreted as:

a standardized operational interval derived from physical clock records.

It is not interpreted as a measured quantity of time itself.

This terminological discipline permits continued use of conventional scientific expressions without allowing them to redefine the ontological meaning of time.

12.7 Rates of physical quantities

Let

$$\widehat{Q}_{A,P} : \mathfrak{R}_{A,P} \longrightarrow \mathbb{R}_{Q,P}$$

be a protocol-defined measurement or estimation map for a physical quantity attributed to bearer A.

For paired sample and clock records, define

$$\Delta_P Q_A := \widehat{Q}_{A,P}(r_{A,2}) - \widehat{Q}_{A,P}(r_{A,1}), \tag{343}$$
$$\Delta_P N_C := N_{C,P}(r_{C,2}) - N_{C,P}(r_{C,1}), \tag{344}$$

and, where $\Delta_P N_C \neq 0$,

$$\boxed{\overline{v}^{P}_{Q_A|C} := \frac{\Delta_P Q_A}{\Delta_P N_C}.} \tag{345}$$

This quantity is an average operational rate of the represented physical quantity relative to the declared clock scale.

It does not divide a physical state by time as defined by ITOF.

The numerator and denominator are numerical outputs produced under declared protocols.

Therefore,

$$\overline{v}^{P}_{Q_A|C} \not\Rightarrow \text{RateOfTime}\,. \tag{346}$$

Fast and slow processes

A physical process may yield a larger or smaller change per clock-output unit than another process.

This comparison concerns:

(i) the physical bearers;
(ii) the measured quantities;
(iii) the clock processes;
(iv) the calibration and units;
(v) and the comparison protocol.

It does not establish that time itself moves faster or slower.

Thus,

$$\overline{v}^{P}_{Q_A|C} > \overline{v}^{P}_{Q_B|C} \not\Rightarrow \text{TimePassesFasterFor}(A). \tag{347}$$

Different rates are differences among bearer histories and their operational representations within one cosmic ordering.

12.8 Comparison of different clocks

Two clocks may employ different mechanisms, units, records, and native reading scales.

Let C_1, C_2 be two clock bearers, and let

$$\Gamma_{i,P_{12}} : \text{Range}(N_{C_i,P_i}) \longrightarrow \mathbb{R}_{P_{12}}, \qquad i \in \{1,2\}, \tag{348}$$

map their readings into one comparison codomain.

Define their protocol-relative numerical difference by

$$\boxed{\Delta N^{(P_{12})}_{C_1C_2} := \Gamma_{1,P_{12}}(n_{C_1}) - \Gamma_{2,P_{12}}(n_{C_2}).} \tag{349}$$

A nonzero difference may reflect:

(a) different clock mechanisms;
(b) different physical histories;
(c) environmental conditions;
(d) motion relative to selected references;
(e) gravitational conditions under a declared model;
(f) calibration;
(g) coupling;

(h) drift;
(i) or device degradation.

It does not entail multiple cosmic extensions:

$$\Delta N^{(P_{12})}_{C_1C_2} \neq 0 \not\Rightarrow \text{DifferentTimes}(C_1, C_2). \tag{350}$$

12.9 Atomic-clock comparisons

High-precision atomic-clock experiments provide a particularly exact instance of the type boundary, including optical-clock networks, differential gravitational-redshift comparisons, and developing nuclear-clock transitions [29, 26, 27, 28, 30, 31, 32, 33].

For two clock bearers,

$$n_{C_1} = N_{C_1,P_1}(r_{C_1}), \qquad n_{C_2} = N_{C_2,P_2}(r_{C_2}). \tag{351}$$

The comparison yields

$$\Delta N^{(P_{12})}_{C_1C_2} = \Gamma_{1,P_{12}}(n_{C_1}) - \Gamma_{2,P_{12}}(n_{C_2}). \tag{352}$$

These quantities are, respectively:

(i) an output of the physical history of C_1;
(ii) an output of the physical history of C_2;
(iii) and a numerical comparison result.

None acquires the type of time:

$$\boxed{n_{C_1} \not\equiv T_{\text{ITOF}}, \qquad n_{C_2} \not\equiv T_{\text{ITOF}}, \qquad \Delta N^{(P_{12})}_{C_1C_2} \not\equiv T_{\text{ITOF}}.} \tag{353}$$

When the outputs differ, the directly supported conclusion is that the two clock systems produced different physical and numerical results under their declared conditions and protocols.

The experiment does not additionally observe an object called time undergoing alteration.

12.10 Clock running faster or slower

The statements

"clock C_1 runs faster than clock C_2"

or

"clock C_2 runs slower"

are interpreted as comparative claims about their output rates under a declared protocol.

Define

$$\mathrm{ClockRate}_{P_{12}}(C_i) \tag{354}$$

from the change of the standardized output of C_i across the comparison domain.

Then

$$\mathrm{ClockRate}_{P_{12}}(C_1) \neq \mathrm{ClockRate}_{P_{12}}(C_2) \tag{355}$$

states unequal physical-output rates.

It does not state:

$$\mathrm{RateOfTimeFor}(C_1) \neq \mathrm{RateOfTimeFor}(C_2). \tag{356}$$

The clock rate belongs to the clock. Time has no bearer-specific rate.

Clock drift

Clock drift is a change in the relation between a clock's output and an adopted operational standard.

A discrepancy initiates assessment of the physical bearer and protocol:

$$\mathrm{ClockDiscrepancy} \Longrightarrow \mathrm{ClockAssessment}\left(C, \Theta_{C,P}, P, r_C\right). \tag{357}$$

Relevant causes may include:

(a) temperature variation;
(b) mechanical or electronic degradation;
(c) power instability;
(d) environmental coupling;
(e) calibration error;
(f) frequency shift;
(g) component ageing;
(h) software or counting error;
(i) or record corruption.

The diagnostic conclusion concerns the clock and its conditions, not an acceleration, slowing, damage, discontinuity, or deformation of time.

12.11 Clock stopping and failure

A clock may stop producing valid records.

Define

$$\mathrm{ClockFailure}_P(C; s) \tag{358}$$

to state that the bearer no longer performs its declared clock function under protocol P at stage s.

Clock failure does not entail identity ending:

$$\text{ClockFailure}_P(C; s) \nRightarrow \text{End}_C(s). \tag{359}$$

A failed clock may remain physically realized as the same device.

Likewise, stopping of clock output does not stop the common cosmic succession or the physical change of other systems:

$$\text{NoClockReadingAfter}_P(C; s) \nRightarrow \text{CosmicSuccessionStopsAt}(s). \tag{360}$$

Where the clock identity remains realized, it also remains subject to CMA despite its functional failure.

Ideal and real clocks

A real clock is a material physical system with a bearer-specific history.

An ideal clock is a modelling limit whose output is stipulated to track a selected theoretical quantity with specified accuracy or exactness.

Therefore,

$$\text{IdealClockModel} \not\equiv \text{RealClockBearer}\,. \tag{361}$$

Agreement between a real clock output and an idealized model may support the model within its tested domain. It does not convert the model quantity into the ontological definition of time.

The model remains a representation of selected physical and numerical relations.

12.12 Synchronization

Synchronization is a protocol-relative relation imposed upon or inferred from clock records.

Let

$$\text{Sync}_{F,P}(r_{C_1}, r_{C_2}) \tag{362}$$

state that synchronization convention F under protocol P classifies the two records as synchronized.

The convention may use:

(i) signal exchange;
(ii) transport or comparison of clocks;
(iii) a common source;
(iv) network correction;
(v) calculated propagation adjustments;
(vi) or another adopted operational procedure.

Synchronization does not create common-stage co-presence and does not define time:

$$\mathrm{Sync}_{F,P}(r_{C_1}, r_{C_2}) \nRightarrow \mathrm{SameCosmicStageExactlyIdentified}\,. \tag{363}$$

Conversely, two systems may be present at the same common cosmic stage without their records being operationally synchronized.

Common-stage unity is ontic. Synchronization is a procedure for organizing records.

12.13 Simultaneous clock readings

Equal clock readings do not establish identity of physical occurrence, bearer state, or cosmic stage:

$$N_{C_1,P_1}(r_1) = N_{C_2,P_2}(r_2) \nRightarrow \mathrm{SameCosmicStage}(r_1, r_2). \tag{364}$$

The equality may arise from:

(a) calibration;
(b) reset;
(c) repeated display values;
(d) periodicity;
(e) convention;
(f) or numerical coincidence.

A warranted same-stage claim requires an independent bearer- and record-to-stage inference bridge.

12.14 Local clock conventions

A local civil clock label is constructed from:

(i) one or more standardized clock systems;
(ii) adopted units and scales;
(iii) geographical or political zone rules;
(iv) correction and dissemination systems;
(v) and social conventions.

Let

$$\mathrm{LocalClockLabel}_{Z,P}(r_C) \tag{365}$$

denote the label assigned under zone convention Z.

Two regions may assign different labels to records realized at one common cosmic stage:

$$\mathrm{LocalClockLabel}_{Z_1,P_1}(r_1) \neq \mathrm{LocalClockLabel}_{Z_2,P_2}(r_2) \nRightarrow \mathrm{DifferentCosmicTimes}\,. \tag{366}$$

The difference belongs to clock outputs and local conventions.

12.15 Time zones

A time zone is a conventional rule system associating geographical or administrative regions with standardized clock offsets and date practices.

It is not a temporal domain.

Therefore,

$$\mathrm{TimeZone}(Z) \not\Rightarrow \mathrm{IndependentTime}(Z). \tag{367}$$

A region does not enter a new time when a political authority changes its zone designation or offset.

The local clocks and labels change under the adopted rule. The common cosmic ordering does not.

Daylight-saving and administrative changes

A jurisdiction may advance or retard its civil clock label under an administrative convention.

Such a change may produce:

(a) repeated civil labels;
(b) skipped labels;
(c) changed schedules;
(d) and altered operational comparisons.

It does not repeat, remove, insert, or reverse common cosmic stages.

Thus,

$$\mathrm{CivilClockAdjustment}(Z) \not\Rightarrow \mathrm{CosmicOrderAdjustment}\,. \tag{368}$$

A repeated local clock label is a recurrence in the reporting convention, not a repeated stage.

12.16 Calendar dates

A calendar date is a conventional classification built from selected astronomical cycles, civil rules, clock outputs, historical conventions, and local zone assignments.

Let

$$\mathrm{CalendarDate}_{K,Z}(s) \tag{369}$$

denote the date label assigned under calendar K and zone convention Z to records associated with stage s.

Different date labels may apply at the same common cosmic stage:

$$\mathrm{CalendarDate}_{K,Z_1}(s) \neq \mathrm{CalendarDate}_{K,Z_2}(s). \tag{370}$$

This does not entail different times:

$$\text{DifferentLocalDates}(Z_1, Z_2; s) \not\Rightarrow \text{DifferentCosmicTimes}(Z_1, Z_2). \tag{371}$$

The date difference belongs to representation and convention, not to the universal cosmic succession.

The civil day

A civil day is an operational and conventional interval defined through clock readings and calendar rules.

It need not coincide exactly with:

(i) a local illumination cycle;
(ii) one complete terrestrial rotation under every physical definition;
(iii) a biological cycle;
(iv) or a fixed number of common cosmic stages.

Accordingly,

$$\text{CivilDay} \not\equiv \text{CosmicStageDomainSegment}\,. \tag{372}$$

Civil days remain highly useful units for human organization. Their conventional status does not diminish that usefulness.

Date boundaries and the international date line

A conventional date boundary may assign different dates to nearby regions or to one bearer crossing the boundary.

Crossing such a boundary changes the local date attribution. It does not move the bearer forward or backward in cosmic succession:

$$\text{CrossesDateBoundary}(A) \not\Rightarrow \text{MovesBetweenTimes}(A). \tag{373}$$

The physical bearer continues its one ordered history

$$\mathcal{H}_A = (I_A, \prec_C|_{I_A}, X_A)\,.$$

Only the applicable civil label changes.

Night, day, clock labels, and dates

Night and day are local illumination states. Clock readings are physical outputs. Dates and zones are conventional classifications.

These four types must remain distinct:

$$
\begin{aligned}
\mathsf{IlluminationState} &\neq \mathsf{ClockOutput}, \\
\mathsf{ClockOutput} &\neq \mathsf{CalendarDate}, \\
\mathsf{CalendarDate} &\neq \mathsf{TimeZone}, \\
\mathsf{TimeZone} &\neq \mathsf{ITOFTemporalDenotation}.
\end{aligned}
\tag{374}
$$

A local region may be in daylight while its civil clock reports one label and another region in darkness reports another label and date.

All then-existing systems remain members of the same common cosmic stage.

12.17 Records do not identify exact cosmic stages automatically

A particular physical clock record is realized in its record bearer at an actual common cosmic stage:

$$
\text{RecordRealizedAt}_C(r_C, s). \tag{375}
$$

This ontic relation does not make the record identical with the stage:

$$
r_C \not\equiv s. \tag{376}
$$

Let $\mathcal{C}^{\text{clock}}_{r_C}$ denote the fully typed claim that record r_C identifies one exact common cosmic stage. The numerical reading by itself does not warrant that claim:

$$
N_{C,P}(r_C) = n \not\Rightarrow \text{WarrantedUniqueStageAssignment}_{P,M}\left(\mathcal{C}^{\text{clock}}_{r_C}\right). \tag{377}
$$

The record possesses an actual bearer-stage realization at the ontic level. The non-entailment concerns whether the numerical output alone provides epistemically adequate grounds for identifying that exact member of $\mathcal{S}_C$.

A warranted unique-stage assignment requires additional information, which may include:

(i) the numerical reading;
(ii) the numerical identity and provenance of the record;
(iii) the identity and physical history of the clock bearer;
(iv) the calibration and operating protocol;
(v) the relation between the clock record and the target occurrence;
(vi) and a validated record-to-stage inference bridge.

Repeated readings, resets, periodic outputs, and equal readings from different clocks prevent the construction of a universal reading-to-stage inverse from the numerical value alone.

12.18 Clock-based formation and ending estimates

Clock readings may help constrain a formation, motion, threshold, or ending window.

For example,

$$\text{ClockBoundedRecordSet}_{P,M}(A, W_N) \Longrightarrow \text{OperationallyConstrains}_{P,M}(W_A)\,. \tag{378}$$

The resulting W_A is a protocol- and model-relative reconstruction window.

It does not convert clock readings into cosmic stages and does not make the first recorded reading the exact ontic formation or ending boundary.

12.19 Predictive clock use

A model may predict that a physical occurrence will be associated with a future clock-reading range.

Let

$$\text{PredictedReadingWindow}_{P,M}(A, C; [n_1, n_2]) \tag{379}$$

state such a prediction.

The interval $[n_1, n_2]$ belongs to the clock's numerical scale.

The prediction does not make the future occurrence attained and does not identify a set of future cosmic stages without an additional model bridge.

Clock-based prediction remains a relation among:

(i) a physical target bearer;
(ii) a physical clock bearer;
(iii) their reconstructed histories;
(iv) a quantitative model;
(v) and a protocol.

Empirical value without ontological transfer

ITOF does not deny the extraordinary empirical precision or practical importance of clocks.

Clock systems support:

(a) experimental control;
(b) navigation;
(c) telecommunications;
(d) astronomy;
(e) engineering;
(f) medicine;
(g) computation;
(h) and social coordination.

Their success warrants confidence in the physical models and protocols connecting clock behaviour to selected phenomena within tested domains.

It does not warrant the additional ontological inference:

$$\text{SuccessfulClockPrediction} \Longrightarrow \text{ClockOutputIsTime}\,. \tag{380}$$

Predictive success and ontological identity remain distinct.

12.20 Preparation for the relativistic confrontation

Relativistic models assign coordinate and metric quantities to physical worldlines and often relate ideal clock readings to a proper-time functional.

V29/F9 retains the type boundary:

$$\mathrm{ProperTimeFunctional} \not\equiv T_{\mathrm{ITOF}}, \tag{381}$$

and

$$\mathrm{RealClockOutput} \not\equiv \mathrm{ProperTimeFunctional}\,. \tag{382}$$

The first statement rejects the relativistic functional as a definition of time. The second distinguishes a material clock output from the mathematical quantity used to model it.

The complete foundational rejection of relativistic temporal ontology is developed in Section 17.

13. Observation, Measurement, Records, and Exact-Stage Restraint

13.1 Ontic occurrence and observational access

Physical realization and observational access are different propositions.

For a physical bearer A and a common cosmic stage $s \in I_A$,

$$\mathrm{Occurrence}_A(s) \not\equiv \mathrm{AccessToOccurrence}_{P,M}(A; s). \tag{383}$$

The first proposition concerns what is physically realized in the bearer. The second concerns whether a protocol, record chain, and model provide epistemic access to that realization.

Accordingly,

$$\mathrm{PhysReal}^+_A(s) \not\Rightarrow \mathrm{Detected}_{P,M,\varepsilon}(A; s), \tag{384}$$

and

$$\neg\,\mathrm{Detected}_{P,M,\varepsilon}(A; s) \not\Rightarrow \neg\,\mathrm{PhysReal}^+_A(s). \tag{385}$$

A bearer may undergo positive physical realization without producing an accessible manifestation under the selected variables, detector, sensitivity, sampling regime, and inference model.

This distinction does not make physical realization immune to evidence. It states that an epistemic proposition cannot be converted into an ontic proposition without an adequate physical and inferential bridge.

13.2 The measurement chain

A valid evidential chain requires:

(i) a physical occurrence in an identified bearer;
(ii) interaction with a physical access channel;
(iii) physical realization of a record;
(iv) extraction of a reading;
(v) and a validated inference to a restricted scientific claim.

The general chain is

Golden formulation: measurement and evidential chain

$$\boxed{\text{Occurrence} \rightsquigarrow_{\text{phys}} \text{AccessInteraction} \rightsquigarrow_{\text{phys}} \text{RecordRealization} \rightsquigarrow_{\text{phys}} \text{Reading} \longrightarrow \text{Claim}\,.} \tag{386}$$

The first three arrows represent declared physical relations. The final arrow represents a declared inferential relation.

No arrow is an identity relation:

$$\text{Occurrence} \not\equiv \text{RecordRealization} \not\equiv \text{Reading} \not\equiv \text{Claim}\,. \tag{387}$$

A failure of bearer attribution, access-channel validity, record provenance, reading extraction, or inferential adequacy blocks the unrestricted transfer of information through the chain.

13.3 Measurement systems as physical bearers

The sample, apparatus, detector, record bearer, observer, laboratory supports, and relevant environmental systems are themselves physical systems.

For a declared protocol P, define the core bearer family by

$$\mathcal{L}_P^{\text{core}} := \{A_{\text{sample}}, A_{\text{apparatus}}, A_{\text{detector}}, A_{\text{record}}, A_{\text{observer}}\}\,, \tag{388}$$

and define the wider protocol-relevant system family by

$$\mathcal{L}_P := \mathcal{L}_P^{\text{core}} \cup \mathcal{E}_P^{\text{sys}}, \tag{389}$$

where $\mathcal{E}_P^{\text{sys}}$ contains declared environmental, supporting, control, and reference systems relevant to the protocol.

The named core bearers remain numerically distinct where their independent bearer criteria are satisfied:

$$X, Y \in \mathcal{L}_P^{\text{core}} \wedge X \neq Y \Longrightarrow \text{BearerDistinct}(X, Y). \tag{390}$$

Bearer distinction does not require physical isolation. A detector may be a constituent or subsystem of a composite apparatus while remaining a distinct bearer under its own criterion.

For every protocol-relevant bearer whose identity is realized at an actual common stage,

$$X \in \mathcal{L}_P \wedge X \in \mathcal{S}_{\text{phys}}(s) \Longrightarrow \text{PhysReal}_X^+(s). \tag{391}$$

There is no physically stationary observer, detector, or instrument outside the common cosmic extension.

This does not make measurement impossible. Calibration, isolation, controls, differential design, provenance, intervention analysis, and uncertainty analysis permit selected relations among changing systems to be investigated.

13.4 Systems, factors, and experimental influence

A protocol may involve both physical bearers and physical factors.

Define the declared system-to-system influence network by

$$\mathcal{N}_P(s) := \{(X, Y) \in \mathcal{L}_P \times \mathcal{L}_P \mid \text{PhysicalInfluence}_P(X, Y; s)\}, \tag{392}$$

and define the relevant physical-factor family by

$$\mathcal{F}_P(s) := \{F \mid \exists X \in \mathcal{L}_P, \text{RelevantPhysicalFactor}(F, X; s)\}. \tag{393}$$

A member of $\mathcal{F}_P(s)$ need not be a separate physical bearer. It may be a state, property, relation, exchange, boundary condition, or mechanism borne by one or more physical systems.

Conversely, a member of $\mathcal{L}_P$ may act as an influencing bearer through its physical engagements.

Thermal, mechanical, electromagnetic, chemical, biological, structural, and environmental contributions may coexist without erasing bearer identity or merging all participating systems into one bearer.

13.5 Measurement interaction and target change

Measurement interaction may alter the target, detector, apparatus, record bearer, or access channel.

However,

$$\text{MeasurementInteraction}_P(A, D; s) \not\Rightarrow \text{End}_A(s). \tag{394}$$

A measurement-induced alteration does not automatically terminate the identity of the measured bearer.

The protocol must state:

(a) which bearer is affected;
(b) which physical variables are altered;
(c) whether the alteration is relevant to the claim;
(d) whether it is controlled or corrected;

(e) and whether bearer identity persists.

Measurement-induced change is one physical contribution within the experimental arrangement. It is not evidence that time acts upon the target.

13.6 Records, stages, and typed realization

A physical record and a common cosmic stage have different types.

Let r be a physical record and $s \in \mathcal{S}_C$. Then

$$\mathrm{Type}(r) = \mathsf{PhysicalRecord}, \qquad \mathrm{Type}(s) = \mathsf{CommonCosmicStage}, \tag{395}$$

and

$$r \not\equiv s. \tag{396}$$

A record may nevertheless be physically realized in a declared record bearer B_R at a common cosmic stage:

$$B_R \in \mathcal{U}_{\mathrm{phys}}, \qquad \mathrm{RecordRealizedAt}_{B_R}(r, s). \tag{397}$$

This relation does not turn the record into the stage and does not make record order identical with cosmic-stage order.

The record belongs to the physical history of its record bearer.

13.7 Source occurrence and record realization

Let $\chi_A(s_E)$ be a physical occurrence in source bearer A, and let r be a record physically realized in record bearer B_R.

A valid record relation may be written as

$$\mathrm{RecordOf}_{P,M}\left(r, \chi_A(s_E)\right). \tag{398}$$

The relation does not imply identity:

$$r \not\equiv \chi_A(s_E), \qquad r \not\equiv X_A(s_E), \qquad r \not\equiv s_E. \tag{399}$$

A record may preserve physically transmitted, deposited, or stored information concerning the source occurrence. It does not become the source occurrence, its complete state, or its common cosmic stage.

13.8 Record provenance and bearer attribution

A record has evidential force only where its provenance and attribution are sufficiently established.

Define

$$\text{ValidProvenance}_{P,M}(r, B_R, A, \chi) \tag{400}$$

to include warranted relations among:

(i) the physical record r;
(ii) the record bearer B_R;
(iii) the physical access or transmission chain;
(iv) the attributed source bearer A;
(v) and the target occurrence or property χ.

Without valid provenance,

$$\text{PhysicalRecord}(r) \nRightarrow \text{Warrant}_{P,M}\left[\text{ClaimAbout}(A, \chi)\right]. \tag{401}$$

A physically genuine record may still be misattributed, contaminated, duplicated, reordered, or interpreted under an invalid model.

13.9 Reading extraction

A reading is a protocol-relative extraction from one or more physical record states.

Let

$$Y_{D,P} : \mathfrak{R}_{D,P} \longrightarrow \mathfrak{Y}_{D,P} \tag{402}$$

be a detector- or instrument-specific reading map.

For a record r,

$$y = Y_{D,P}(r). \tag{403}$$

The output may be a number, category, image, spectrum, sequence, estimated parameter, or another protocol-defined representation.

The reading is not the complete physical state of either the record bearer or the source bearer:

$$y \not\equiv X_{B_R}(s_R), \qquad y \not\equiv X_A(s_E). \tag{404}$$

Operational manifestations

Examination observes protocol-accessible manifestations and compares physical records.

A positive record difference requires:

(a) valid attribution to the same continuing bearer where that is the claim;
(b) a declared state component;
(c) a declared comparison criterion;
(d) adequate record provenance;
(e) a difference exceeding accepted uncertainty and operational variation;
(f) and a valid order bridge where ordered physical change is claimed.

For records r_1, r_2, define schematically

$$\begin{aligned} &\mathrm{PositiveWitness}^{\Gamma}_{A,k;P,M}(r_1, r_2) \\ &\quad \Longrightarrow \mathrm{Warrant}_{P,M}\left[X_{A,k}(s_1) \not\equiv_{\Gamma} X_{A,k}(s_2)\right]. \end{aligned} \tag{405}$$

The conclusion is restricted to the identified bearer, selected component, criterion, protocol, model, and supported source domain.

It does not inspect every member of I_A.

13.10 Finite witnesses and stagewise exhaustion

A restricted empirical witness does not amount to stage-by-stage inspection of the entire bearer history:

$$\mathrm{RestrictedEmpiricalWitness}_{A;P,M}(r_1, r_2) \nRightarrow \mathrm{StagewiseExhaustiveTest}_{A;P,M}(I_A). \tag{406}$$

It also does not automatically identify one exact common cosmic stage:

$$\mathrm{RestrictedEmpiricalWitness}_{A;P,M}(r_1, r_2) \nRightarrow \mathrm{ExactCosmicStageIdentified}_{A;P,M}(\chi). \tag{407}$$

The first non-entailment prevents conversion of finite evidence into inspection of every applicable stage.

The second prevents conversion of the stage at which an effect is resolved, recorded, or read into the exact stage at which the relevant physical occurrence first became realized or noticeable.

13.11 Candidate-stage inference

ITOF supplies no canonical, identity-preserving, or uniquely determining map from records to common cosmic stages.

A declared physical model may nevertheless produce a fallible candidate-stage set:

$$\mathrm{CandidateStages}^{A,\chi}_{P,M}(r) \subseteq \mathcal{S}_C. \tag{408}$$

Here:

- (i) A is the bearer to which the occurrence is attributed;
- (ii) χ is the target occurrence or boundary;
- (iii) r is the relevant record or record family;
- (iv) and P, M specify the protocol and reconstruction model.

The target may be a source realization, emission, arrival, threshold manifestation, identity formation, identity ending, or another declared physical occurrence.

The candidate-stage set may be empty, broad, non-unique, or reduced under additional evidence.

It remains protocol- and model-conditioned:

$$\mathrm{CandidateStages}^{A,\chi}_{P,M}(r) \not\equiv I_A. \tag{409}$$

Membership in the candidate set does not itself establish that the occurrence happened at that stage:

$$s \in \mathrm{CandidateStages}^{A,\chi}_{P,M}(r) \not\Rightarrow \chi_A(s). \tag{410}$$

For later formulas, abbreviate typed membership in that set by

$$\mathrm{RecordStageCandidate}_{A,\chi;P,M}(r,s) \Longleftrightarrow s \in \mathrm{CandidateStages}^{A,\chi}_{P,M}(r). \tag{411}$$

The relation supplies only a candidate link from a declared record to a stage for a declared bearer and occurrence. It is not an occurrence warrant.

13.12 Exact-stage restraint

The ontic status of a formation boundary, ending boundary, source event, or threshold crossing is distinct from warranted knowledge of its exact stage.

For any fully typed claim $\mathcal{C}$ that one exact cosmic stage is scientifically assigned, let $\mathrm{WarrantedUniqueStageAssignment}_{P,M}(\mathcal{C})$ denote the corresponding protocol- and model-relative warrant.

A finite record comparison does not by itself justify such a claim. With $\mathcal{C}^{\mathrm{obs}}_{A,\chi;r_1,r_2}$ denoting the exact-stage claim generated from that comparison,

$$\boxed{\mathrm{ValidDifferenceWitness}_{A;P,M}(r_1,r_2) \not\Rightarrow \mathrm{WarrantedUniqueStageAssignment}_{P,M}\left(\mathcal{C}^{\mathrm{obs}}_{A,\chi;r_1,r_2}\right).} \tag{412}$$

This is an epistemic restraint.

It does not assert that the occurrence lacks one actual ontic stage. It states that the finite protocol and records do not automatically identify that stage exactly.

A unique-stage assignment requires additional warrant concerning:

(1) bearer identity and attribution;
(2) the target occurrence;
(3) record provenance;
(4) the access or propagation chain;
(5) detector and reading validity;
(6) exclusion of alternative candidate stages;
(7) and sufficient resolution for the claimed distinction.

First detection and first physical realization

The first accepted detection is a boundary in the detector, record, and decision history.

It is not automatically the first physical realization of the source manifestation:

$$\begin{aligned}&\mathrm{FirstAcceptedDetection}_{P,M}(A,\chi;r_d) \wedge \mathrm{RecordStageCandidate}_{A,\chi;P,M}(r_d,s_d)\\ &\qquad \not\Rightarrow \mathrm{FirstPhysicalRealizationOf}(A,\chi;s_d).\end{aligned} \tag{413}$$

Earlier physical contributions may have been:

(i) below the detection threshold;
(ii) outside the sampled component;
(iii) unresolved by the selected variables;
(iv) unrecorded;
(v) masked by noise or other physical effects;
(vi) or distributed across several bearer components.

The detection belongs physically to the detector and record histories. The source manifestation may have begun or accumulated earlier.

Threshold crossing

Let $M_A(r)$ be a declared observable or detector output and θ a declared operational threshold.

Then

$$\begin{aligned} &M_A(r_d) \geq \theta \wedge \mathrm{RecordStageCandidate}_{A,\chi_\theta;P,M}(r_d, s_d) \\ &\quad \not\Rightarrow (\mathrm{AttainedFormation}_A(s_d) \vee \mathrm{End}_A(s_d)) \,. \end{aligned} \tag{414}$$

A threshold crossing does not automatically establish formation or ending of the bearer.

Either conclusion requires an independently validated identity criterion, bearer attribution, measurement model, and record-to-stage bridge.

Nor does the first resolved threshold crossing automatically identify the exact stage at which the physical manifestation first became noticeable.

13.13 Formation and ending records

The first accepted record judged to show that a bearer exists does not automatically identify its formation stage:

$$\begin{aligned} &\mathrm{FirstAcceptedRecordOfExistence}_{P,M}(A; r) \wedge \mathrm{RecordStageCandidate}_{A,\mathsf{existence};P,M}(r, s_r) \\ &\quad \not\Rightarrow \mathrm{AttainedFormation}_A(s_r). \end{aligned} \tag{415}$$

Likewise, the first accepted record judged to show that a bearer has ended does not automatically identify its ending stage:

$$\begin{aligned} &\mathrm{FirstAcceptedRecordOfEnding}_{P,M}(A; r) \wedge \mathrm{RecordStageCandidate}_{A,\mathsf{ending};P,M}(r, s_r) \\ &\quad \not\Rightarrow \mathrm{End}_A(s_r). \end{aligned} \tag{416}$$

Valid evidence may instead warrant boundary windows:

$$f_A \in W_A^{\mathrm{form}}, \qquad e_A \in W_A^{\mathrm{end}}. \tag{417}$$

The windows express epistemic localization limits. They do not replace the unique ontic formation and ending members.

13.14 Measurement completion is not ontological completion

Completion of a measurement does not stop physical change in the sample, apparatus, detector, observer, record bearer, or environment.

Where the identity of $X \in \mathcal{L}_P$ continues,

$$s \in I_X^+ \Longrightarrow \mathrm{PhysReal}_X^+(s). \tag{418}$$

Operational completion of a test is not an ontological stopping point.

Where a bearer identity ends during the protocol, its ending is itself positive physical realization. Any warranted successor identity begins its own physical history under the ending, transformation, and successor architecture.

13.15 Past reconstruction and uncertainty

Past reconstruction may use:

(i) propagation models;
(ii) provenance;
(iii) calibration;
(iv) material degradation;
(v) decay relations;
(vi) stratigraphy;
(vii) genetic inheritance;
(viii) historical records;
(ix) or other domain-valid physical relations.

Let

$$\widehat{\mathcal{H}}_{A;P,M} = \mathrm{Reconstruct}_{P,M}\left(\mathcal{R}_{A;P,M}\right) \tag{419}$$

denote the protocol- and model-conditioned reconstruction of bearer A's physical history from the relevant record family.

The reconstruction is not the complete ontic history; that nonidentity is fixed by Equation (181).

Possible reconstruction outputs include:

(a) an ordered event sequence;
(b) a state-value interval;
(c) a formation or ending window;
(d) a spatial uncertainty region;
(e) a candidate-stage set;
(f) a family of admissible histories;
(g) or an unresolved result.

Uncertainty describes the limits of the available evidence and model. It does not imply that the ontic occurrence itself was distributed across the same evidential range.

A reconstruction never converts a record into the earlier occurrence and never gives a record the type of a common cosmic stage.

14. Light, Distance, and Remote Physical Records

14.1 The governing status of light

In the present analysis, light and other electromagnetic radiation are treated as physical factors and record carriers.

They are not treated as:

(i) time;
(ii) a portion of time;
(iii) a common cosmic stage;
(iv) a clock merely by propagating;
(v) or a carrier that transports an earlier stage to a later observer.

A radiative process may be represented through fields, quanta, waves, emission events, propagating signals, or another domain-appropriate physical ontology.

The choice among those physical representations does not alter the governing type boundary:

$$\boxed{\text{RadiativeCarrier} \not\equiv T_{\text{ITOF}}, \qquad \text{RadiativeCarrier} \not\equiv \text{CommonCosmicStage}\,.} \tag{420}$$

The radiative carrier may preserve and transmit physically encoded information about a source occurrence. It does not preserve or transmit the source's cosmic stage as an object.

The source–record chain

Let:

(a) $S \in \mathcal{U}_{\text{phys}}$ be a source bearer;
(b) L be the declared radiative carrier or propagation process;
(c) $D \in \mathcal{U}_{\text{phys}}$ be a detector bearer;
(d) and $B_R \in \mathcal{U}_{\text{phys}}$ be the bearer in which the accepted record is physically realized.

The general physical chain is

$$\boxed{\begin{aligned} \text{PhysReal}^{+}_{S}(s_S) &\rightsquigarrow_{\text{phys}} \text{Emission}_S(e; s_E) \\ &\rightsquigarrow_{\text{phys}} \text{Propagation}_L(\pi) \\ &\rightsquigarrow_{\text{phys}} \text{ArrivalAt}_D(a; s_A) \\ &\rightsquigarrow_{\text{phys}} \text{DetectorInteraction}_D(d; s_D) \\ &\rightsquigarrow_{\text{phys}} \text{RecordState}_{B_R}(q; s_R). \end{aligned}} \tag{421}$$

Every arrow denotes a physical relation requiring a domain model.

The chain does not state that every source change necessarily produces a radiative signal, that every emitted signal reaches the detector, or that every detector interaction produces an accepted record.

Each transition may fail, be modified, remain inaccessible, or require additional physical conditions.

14.2 Source realization and emission

A physical realization of the source and an emitted signal are distinct occurrences:

$$\mathrm{PhysReal}^{+}_{S}(s_S) \not\equiv \mathrm{Emission}_S(e; s_E). \tag{422}$$

A source realization may alter:

(i) luminosity;
(ii) spectral content;
(iii) polarization;
(iv) emission direction;
(v) pulse structure;
(vi) intensity distribution;
(vii) or another radiatively accessible property.

A validated source model may establish a physical relation between that realization and the emitted radiation.

Without such a relation,

$$\mathrm{RadiativeRecordDetected}(q) \not\Rightarrow \mathrm{SpecifiedSourceChange}(S, \chi). \tag{423}$$

The emitted radiation is evidence-bearing physical output. It is not the complete source state.

14.3 Emission and source-stage restraint

Where the source realization and emission are stage-resolved, a physical model may warrant

$$s_S \preceq_C s_E. \tag{424}$$

Equality is not excluded where the source realization and emission are classified at the same common cosmic stage.

Strict ordering may apply where the declared source mechanism requires an intervening physical process.

ITOF does not supply that mechanism from the definition of time or from CMA. The ordering must be justified by the source physics and the evidential bridge.

Propagation as a physical process

Propagation is a physical process or relation between emission and arrival.

It may be affected by:

(a) path length;
(b) motion of source, detector, or intervening systems;
(c) intervening media;
(d) dispersion;
(e) absorption;
(f) scattering;
(g) re-emission;
(h) gravitational lensing under the adopted physical model;
(i) path multiplicity;
(j) frequency-dependent response;
(k) and other source–path–detector conditions.

Propagation is not the movement of a stage through space.

It is a physical history of the radiative carrier and the systems with which it interacts.

For a stage-resolved emission and arrival,

$$\mathrm{ValidPropagationLink}_{P,M}(e, a; \pi) \Longrightarrow s_E \prec_C s_A. \tag{425}$$

The strict order states that arrival is later than emission.

It does not assign a metric magnitude to the cosmic ordering and does not identify the operational propagation interval with time as defined by ITOF.

14.4 Arrival, detection, and record realization

Arrival at a detector, detector interaction, reading extraction, and record acceptance are different occurrences.

Thus,

$$\begin{aligned} \mathrm{ArrivalAt}_D(a; s_A) &\not\equiv \mathrm{DetectorInteraction}_D(d; s_D), \\ \mathrm{DetectorInteraction}_D(d; s_D) &\not\equiv \mathrm{RecordState}_{B_R}(q; s_R). \end{aligned} \tag{426}$$

A detector may integrate arriving radiation, apply thresholds, combine successive interactions, amplify a signal, transform it electronically, or transfer it to another record bearer.

Accordingly, stage-resolved models may warrant

$$s_A \preceq_C s_D \preceq_C s_R. \tag{427}$$

The equalities or strict inequalities depend upon the adopted event resolution and physical detector model.

No automatic claim of instantaneous detection or recording is made.

14.5 The remote record is not the remote occurrence

For a remote source occurrence $\chi_S(s_E)$ and a detector record q realized at s_R,

$$\mathrm{RemoteRecordOf}_{P,M}\left(q, \chi_S(s_E)\right) \tag{428}$$

is a physical and epistemic relation.

It is not an identity relation:

$$\boxed{q \not\equiv \chi_S(s_E), \qquad q \not\equiv X_S(s_E), \qquad q \not\equiv s_E.} \tag{429}$$

The record may constrain selected features of the source occurrence. It does not reproduce the source's complete physical state and does not become the earlier stage at which the source event occurred.

The meaning of observing a remote past occurrence

The expression *observing a remote source in the past* is interpreted as follows:

A detector presently realizes a record physically linked to an earlier source occurrence through a validated propagation chain.

It does not mean that:

(i) the earlier cosmic stage has travelled to the detector;
(ii) the observer has entered that earlier stage;
(iii) the earlier stage has become present again;
(iv) or the source and detector occupy different times.

The source event was realized at s_E. The detector record is realized at s_R, with

$$s_E \prec_C s_R. \tag{430}$$

The two occurrences belong to the same irreversible cosmic ordering.

14.6 Source and detector histories

The source and detector possess distinct physical histories:

$$\mathcal{H}_S = \left(I_S, \prec_C|_{I_S}, X_S\right), \qquad \mathcal{H}_D = \left(I_D, \prec_C|_{I_D}, X_D\right). \tag{431}$$

The remote record belongs physically to the detector or record-bearer history at reception.

Its represented content concerns an earlier portion of the source history.

Therefore,

$$\mathrm{RemoteRecordOf}(q, S) \not\Rightarrow q \in \mathrm{OnticStateDomain}(S). \tag{432}$$

Source attribution connects the histories without identifying them.

The source may continue or end before reception

The source need not remain the same numerical bearer until the detector receives the record.

A source may:

(a) continue changing under the same identity;
(b) undergo transformation;
(c) end and produce successors;
(d) or cease before the emitted signal reaches the detector.

Thus,

$$\mathrm{RemoteRecordOf}(q, \chi_S(s_E)) \not\Rightarrow s_R \in I_S. \tag{433}$$

The record can remain physically valid evidence of the earlier source occurrence even where the original source identity no longer exists at reception.

Continuous flux and successive records

Remote sources commonly produce continuing or recurrent radiative flux, not one isolated object called "the light" followed by an unrelated second object.

Successive portions of the flux may encode successive physical conditions of the source.

Let

$$e_1, e_2$$

be two attributed emissions and

$$q_1, q_2$$

their corresponding detector records.

A scientifically valid comparison requires:

(1) secure source attribution;
(2) distinction of the two emissions and records;
(3) a valid source model;
(4) a valid propagation model;
(5) a valid detector-response model;
(6) and a bridge preserving the relevant order.

Only under these conditions may the record difference be used to constrain source variability.

14.7 Operational source–reception accounting

Let

$$E_i^{(P,M)}$$

be the protocol- and model-relative numerical label assigned to emission e_i, let

$$\Pi_i^{(P,M)}$$

be its modeled propagation contribution, and let

$$R_i^{(P,M)}$$

be the corresponding reception label in a common numerical codomain.

Under the declared model,

$$\boxed{R_i^{(P,M)} = E_i^{(P,M)} + \Pi_i^{(P,M)}, \qquad i \in \{1, 2\}.} \tag{434}$$

These are operational or model quantities.

They are not cosmic stages, and the addition is not an algebraic operation on members of $\mathcal{S}_C$.

Define

$$\Delta R^{(P,M)} := R_2^{(P,M)} - R_1^{(P,M)}, \tag{435}$$

$$\Delta E^{(P,M)} := E_2^{(P,M)} - E_1^{(P,M)}, \tag{436}$$

$$\Delta \Pi^{(P,M)} := \Pi_2^{(P,M)} - \Pi_1^{(P,M)}. \tag{437}$$

Then

$$\boxed{\Delta R^{(P,M)} = \Delta E^{(P,M)} + \Delta \Pi^{(P,M)}.} \tag{438}$$

The reception separation is therefore governed by the source-emission separation together with the differential propagation contribution.

14.8 Detector and processing contributions

Where detector integration or processing contributes materially to the reported record label, introduce

$$\delta^D_{i;P,M}.$$

The more complete accounting relation is

$$R_i^{(P,M)} = E_i^{(P,M)} + \Pi_i^{(P,M)} + \delta^D_{i;P,M}. \tag{439}$$

Therefore,

$$\Delta R^{(P,M)} = \Delta E^{(P,M)} + \Delta \Pi^{(P,M)} + \Delta \delta^D_{P,M}. \tag{440}$$

The reduced relation $\Delta R = \Delta E + \Delta \Pi$ is admissible only where detector and processing differences are negligible, common, or independently corrected.

14.9 Cancellation of a common propagation displacement

Suppose the two signals follow effectively the same path under sufficiently stable source–path–detector conditions.

Then

$$\Pi_1^{(P,M)} \approx \Pi_2^{(P,M)}, \tag{441}$$

and hence

$$\Delta\Pi^{(P,M)} \approx 0. \tag{442}$$

If the differential detector contribution is also negligible or corrected,

$$\boxed{\Delta R^{(P,M)} \approx \Delta E^{(P,M)}.} \tag{443}$$

This is the cancellation of a propagation displacement common to both records.

It does not imply that either propagation contribution is zero:

$$\Pi_1^{(P,M)} \approx \Pi_2^{(P,M)} \not\Rightarrow \Pi_1^{(P,M)} \approx 0. \tag{444}$$

The first signal may have undergone a very large propagation interval, and the second may undergo nearly the same interval.

The large common contribution cancels only in the difference between the two reception labels.

Thus, the comparison does not exclude, erase, or deny the first propagation period.

Conditions under which cancellation fails

The approximation

$$\Delta\Pi^{(P,M)} \approx 0$$

must not be presumed where relevant conditions differ.

A non-negligible differential propagation contribution may arise from:

(i) motion of the source;
(ii) motion of the detector;
(iii) changing path geometry;
(iv) lensing or multiple paths;
(v) moving or changing intervening media;
(vi) frequency-dependent dispersion;
(vii) scattering;
(viii) absorption and re-emission;
(ix) path-dependent spectral alteration;
(x) detector relocation;

(xi) or different record-processing conditions.

In such cases, for every admissible value δ in the common numerical codomain,

$$\Delta R^{(P,M)} = \delta \not\Rightarrow \Delta E^{(P,M)} = \delta \tag{445}$$

without adequate propagation and detector correction.

The source separation must not be inferred by subtracting one large assumed constant where the physical conditions do not justify that assumption.

14.10 Spectral and intensity changes

A difference between remote records may arise from:

(a) physical change in the source;
(b) changing emission conditions;
(c) propagation effects;
(d) detector effects;
(e) calibration;
(f) contamination;
(g) or a combination of these.

Therefore,

$$q_1 \not\equiv_\Gamma q_2 \not\Rightarrow X_S(s_1) \not\equiv_{\Gamma_S} X_S(s_2) \tag{446}$$

without a validated source–propagation–detector attribution bridge.

Conversely, equality of selected records does not establish complete source-state equality:

$$q_1 \equiv_\Gamma q_2 \not\Rightarrow X_S(s_1) = X_S(s_2). \tag{447}$$

A source alteration may be omitted by the selected spectral band, spatial resolution, sampling cadence, detector sensitivity, or model.

14.11 Bearer identity across successive remote records

Two records assigned the same astronomical name do not automatically belong to the same numerical source bearer.

A valid continuing-source claim requires

$$\mathrm{RemoteIdentityWarrant}_{P,M}\left[\mathrm{IdCont}_S(s_1, s_2)\right]. \tag{448}$$

The warrant may depend upon:

(i) spatial attribution;
(ii) spectral and morphological continuity;
(iii) physical source models;

(iv) exclusion of source confusion;
(v) record provenance;
(vi) and the domain-specific identity criterion.

Without this warrant, variability between two records may reflect two different bearers, blended sources, or incorrect attribution rather than change in one continuing source.

14.12 Remote records and source-order inference

Let $q_1 \lhd_P q_2$ be the operational order of two received records.

This order does not automatically establish the order of their source emissions:

$$q_1 \lhd_P q_2 \not\Rightarrow e_1 \prec_{\mathrm{src}} e_2. \tag{449}$$

A valid order bridge must account for propagation, path multiplicity, storage, detector processing, and provenance.

Where

$$\mathrm{ValidRemoteOrderBridge}_{S;P,M}(q_1, q_2; e_1, e_2) \tag{450}$$

holds,

$$\begin{aligned} &q_1 \lhd_P q_2 \wedge \mathrm{ValidRemoteOrderBridge}_{S;P,M}(q_1, q_2; e_1, e_2) \\ &\quad \Longrightarrow \mathrm{Warrant}_{P,M}\left[s_{E_1} \prec_C s_{E_2}\right]. \end{aligned} \tag{451}$$

The warrant may establish source ordering without assigning either emission to one exactly known common cosmic stage.

14.13 Remote reconstruction windows

A remote record may constrain a source-history window under a validated model:

$$\begin{aligned} &\mathrm{RemoteRecordOf}_{P,M}(q, S) \\ &\wedge \mathrm{ValidSourceModel}_{P,M}(S) \\ &\wedge \mathrm{ValidPropagationModel}_{P,M} \\ &\wedge \mathrm{ValidDetectorModel}_{P,M}(D) \\ &\quad \Longrightarrow \mathrm{ConstrainsSourceWindow}_{P,M}(q, S, W_{S;P,M}). \end{aligned} \tag{452}$$

The window may belong to:

(a) an emission-coordinate domain;
(b) a model-relative source-history domain;
(c) an operational reconstruction scale;
(d) or a bounded family of source states.

It is not automatically a subset of $\mathcal{S}_C$.

A separately validated bridge may produce a candidate-stage set

$$\text{CandidateStages}^{S,\chi}_{P,M}(q) \subseteq \mathcal{S}_C. \tag{453}$$

The set remains model-conditioned and non-canonical.

14.14 Exact-stage restraint for remote records

A remote record does not by itself warrant one exact cosmic stage for the source occurrence:

$$\boxed{\text{ValidRemoteRecord}_{P,M}(q,S) \not\Rightarrow \text{WarrantedUniqueSourceStage}_{P,M}(q,S,\chi).} \tag{454}$$

A unique assignment requires additional justification concerning:

(1) the numerical source identity;
(2) the source occurrence represented;
(3) the emission mechanism;
(4) the propagation path or path family;
(5) source and detector motion;
(6) the detector response;
(7) record provenance;
(8) and exclusion of alternative admissible reconstructions.

The restraint does not deny that the source occurrence possessed one actual stage.

It denies that the remote record automatically identifies that member of $\mathcal{S}_C$.

14.15 Distance and the Cosmic Moment Axiom

Distance affects physical interaction, signal propagation, records, and access.

It does not divide the common cosmic stage.

For two bearers $A, B \in \mathcal{S}_{\text{phys}}(s)$,

$$\text{SpatiallyDistant}(A,B;s) \not\Rightarrow \neg\,\text{CoPresent}_{\text{C}}(A,B;s). \tag{455}$$

Where both identities are realized at s, CMA applies to each bearer:

$$A, B \in \mathcal{S}_{\text{phys}}(s) \Longrightarrow \text{PhysReal}^{+}_{A}(s) \wedge \text{PhysReal}^{+}_{B}(s). \tag{456}$$

Neither bearer must receive information from the other for common-stage membership or bearer-specific realization to hold.

Signal propagation concerns later access and physical influence, not the creation of common-stage presence.

14.16 No signal causes common-stage unity

The physical chain

$$S \rightsquigarrow_{\text{phys}} L \rightsquigarrow_{\text{phys}} D$$

does not produce the common cosmic stage shared by the bearers then existing.

Therefore,

$$\text{SignalReceived}(S, D; s) \not\Rightarrow \text{CommonStageCreatedFor}(S, D; s). \tag{457}$$

Likewise, failure to receive a signal does not place the distant bearer outside the common cosmic succession.

Common-stage unity is governed by the cosmic domain and population conditions. Signal exchange is a physical relation within that already common ordering.

14.17 Remote variability and UCC

Repeated remote records may provide restricted evidence of source variability.

For this application, three protocol- and model-relative truth-valued conditions are used:

(i) a *restricted remote-change witness*: accepted, same-source records warrant at least one physical difference attributable to S within the reconstructed window;

(ii) *continuity-coverage adequacy*: the declared sampling, record, component, attribution, and gap coverage is adequate for the restricted continuity claim rather than only for an endpoint difference;

(iii) an *accepted continuity model*: the source-identity, propagation, detector, reconstruction, and uncertainty model required by that claim is accepted under P and M.

Define the restricted empirical-continuity conclusion by

$$\begin{aligned}
&\text{UCC}^{\text{emp}}_{S;P,M}\left(\widehat{I}_{S;P,M}, J\right) \\
&\quad\Longleftrightarrow \text{RestrictedRemoteChangeWitness}_{S;P,M}\left(\widehat{I}_{S;P,M}, J\right) \\
&\qquad\wedge \text{ContinuityCoverageAdequate}_{S;P,M}\left(\widehat{I}_{S;P,M}, J\right) \\
&\qquad\wedge \text{AcceptedContinuityModel}_{S;P,M}\left(\widehat{I}_{S;P,M}, J\right).
\end{aligned} \tag{458}$$

This is an epistemic, window-restricted conclusion. A record difference alone does not establish continuity throughout a reconstructed source window, and model acceptance without the declared witness and coverage conditions is not sufficient.

The conclusion is restricted to the reconstructed source window and the records, variables, sensitivities, and model actually used.

It does not establish positive realization at every ontic member of I_S^+.

Remote variability provides evidential support for continuing physical change. It does not exhaust the universal quantifiers of CMA or UCC.

Stars and stellar transformation

A star is treated as a physical bearer only under a declared astrophysical identity criterion.

Repeated records may warrant variability, oscillation, activity, mass loss, physical development, or other changes while the stellar identity persists. Representative observational and modeling contexts include cosmological reconstruction, stellar-end models, transient surveys, variability pipelines, and asteroseismology [34, 35, 37, 38, 39, 56].

None of those changes automatically entails identity ending:

$$\text{StellarVariability}(S; J) \not\Rightarrow \exists e \in J \ \text{End}_S(e). \tag{459}$$

Where terminal collapse or explosive transformation is independently warranted, the former stellar identity may end and one or more successor bearers may form, such as a compact remnant and physically distinct ejecta systems.

The classification must satisfy the identity and production architecture of Section 9; the astronomical appearance of a transient is not by itself a successor proof.

Galaxies and bearer-specific identity criteria

Galaxies require identity criteria different from those used for stars. Classical interaction models illustrate the physical redistribution and merger phenomena that motivate this identity restraint [36].

Interaction, tidal deformation, material redistribution, and merger may:

(i) preserve one or more galactic identities;
(ii) terminate one or more predecessor identities;
(iii) form a successor organization;
(iv) or remain unresolved under the available evidence.

A galaxy must not be treated as a simple star-like bearer merely because both are remote luminous systems.

Constituent stars and material may continue after a galactic identity ends. Their persistence does not prove persistence of the predecessor galaxy.

14.18 Remote stability

A remote source may appear stable under a selected record criterion:

$$q_1 \equiv_{\Gamma_{P,M,D}} q_2. \tag{460}$$

This supports only criterion-relative record stability.

It does not entail

$$X_S(s_1) = X_S(s_2) \tag{461}$$

or

$$\neg\,\text{PhysReal}_S^+(s) \qquad \text{for } s_1 \prec_C s \preceq_C s_2. \tag{462}$$

The unrepresented realization may concern components, wavelengths, spatial scales, mechanisms, or magnitudes outside the protocol's access.

A sufficiently complete adverse study may challenge a restricted source-change claim, but record equality alone is not complete source stasis.

14.19 No private time for remote systems

Delayed access to a remote bearer does not place that bearer in a private time.

The source history satisfies

$$I_S \subseteq \mathcal{S}_C, \tag{463}$$

and the detector history satisfies

$$I_D \subseteq \mathcal{S}_C. \tag{464}$$

Propagation connects distinct occurrences within the same universal ordering.

It does not create one time for the source and another for the detector.

15. Explanatory and Predictive Use of Individual Physical History

15.1 The governing distinction

The complete physical history of a bearer and the evidential reconstruction available to an investigator are different objects.

For a physical bearer A,

$$\mathcal{H}_A = (I_A, \prec_C |_{I_A}, X_A)$$

is the bearer's complete ontic physical history.

By contrast,

$$\widehat{\mathcal{H}}_{A;P,M}$$

is a protocol- and model-conditioned reconstruction warranted by available physical records.

Accordingly, Equation (181) governs the predictive use of reconstructed history.

Explanation and prediction operate through the reconstructed history. They do not provide direct epistemic possession of the complete ontic history.

15.2 Ontic identity-domain prefix

For an actual stage $s \in I_A$, define the attained identity-domain prefix

$$I_A^{\leq s} := \{r \in I_A \mid r = s \ \vee \ r \prec_C s\}. \tag{465}$$

The corresponding ontic physical-history prefix is

$$\mathcal{H}_A^{\le s} := \left(I_A^{\le s}, \prec_C|_{I_A^{\le s}}, X_A|_{I_A^{\le s}} \right). \tag{466}$$

This prefix is an actual part of the bearer's physical history.

It is not:

(i) a detector record;
(ii) a collection of clock readings;
(iii) a coordinate interval;
(iv) an investigator's reconstruction;
(v) or a predictive model.

The prefix exists because those bearer stages and physical states are actually realized within the complete history.

15.3 Operational data cutoff

Prediction ordinarily begins from an operational data cutoff rather than from direct access to one exactly identified cosmic stage.

Let u be a declared cutoff in the native order of protocol P.

All records, calibrations, reconstructions, and model-selection operations admitted into the predictive analysis must be available no later than u.

Define

$$\widehat{\mathcal{H}}_{A;P,M}^{\le u} \tag{467}$$

as the reconstruction of the bearer's physical history warranted by the record family admitted at or before u.

Likewise, define

$$\widehat{\mathcal{G}}_{A;P,M}(u) \tag{468}$$

as the available reconstruction of the bearer's constitution, selected state components, physical environment, relations, and actual engagements at the cutoff.

The types remain distinct:

$$\mathrm{Type}\left(\mathcal{H}_A^{\le s}\right) = \mathsf{OnticPhysicalHistoryPrefix}, \tag{469}$$

$$\mathrm{Type}\left(\widehat{\mathcal{H}}_{A;P,M}^{\le u}\right) = \mathsf{ProtocolModelHistoryReconstruction}. \tag{470}$$

Therefore,

$$\widehat{\mathcal{H}}_{A;P,M}^{\le u} \not\equiv \mathcal{H}_A^{\le s}. \tag{471}$$

The cutoff u need not identify a unique common cosmic stage.

15.4 Historical explanation

A reconstructed individual history may contribute to explanation by showing how the bearer's present or later physical condition depends upon its earlier constitution, transformations, interactions, accumulated effects, and environmental engagements.

Let Y_A be a declared bearer-level outcome or state feature.

A history-informed explanatory claim has the general form

$$\begin{aligned}&\widehat{\mathcal{H}}^{\le u}_{A;P,M} \wedge \widehat{\mathcal{G}}_{A;P,M}(u) \wedge \mathrm{ValidExplanatoryModel}_{P,M}\\ &\quad\Longrightarrow \mathrm{ExplanatoryWarrant}_{P,M}\left[Y_A \mid \widehat{\mathcal{H}}^{\le u}_{A;P,M}, \widehat{\mathcal{G}}_{A;P,M}(u)\right].\end{aligned} \tag{472}$$

The two operator names in Equation (472) are schematic evidential labels rather than new ontological primitives: $\mathrm{ValidExplanatoryModel}_{P,M}$ records the declared adequacy of the explanatory model, and $\mathrm{ExplanatoryWarrant}_{P,M}$ records the resulting restricted inferential warrant.

The conclusion remains restricted to the records, variables, model, bearer criterion, and domain actually used. Historical explanatory value does not imply that the reconstructed history exhausts all physical contributions to the outcome.

Historical dependence and causal restraint

Predictive or explanatory improvement from historical information does not by itself establish that every included historical variable is a physical cause of the outcome.

Thus,

$$\mathrm{HistoryImprovesExplanation}_{P,M}(A, Y_A) \not\Rightarrow \mathrm{EveryHistoricalFeatureCauses}(Y_A). \tag{473}$$

The improvement may arise from:

(a) direct causal contribution;
(b) indirect causal ancestry;
(c) correlation with an omitted physical factor;
(d) accumulated bearer condition;
(e) environmental exposure;
(f) state dependence;
(g) or another model-valid relation.

Causal attribution requires an additional physical and inferential bridge.

15.5 Prediction origin and ontic future target

At the complete-history ontic level, let

$$s_\star \in I_A$$

be an actual prediction-origin stage.

Define an actual later target set by

$$J_A^+(s_\star) \subseteq \{v \in \mathcal{S}_C \mid s_\star \prec_C v\}\,. \tag{474}$$

This target set belongs to the complete-history formulation.

It does not follow that its members are known or exactly stage-resolved at $s_\star$.

The target set may contain stages at which:

(i) the identity of A continues;
(ii) functional failure occurs;
(iii) the identity of A ends;
(iv) transformation outcomes are realized;
(v) or successor identities form.

15.6 Protocol-relative future evaluation window

An operational prediction study does not normally possess $J_A^+(s_\star)$ as an exactly identified cosmic-stage set.

Instead, it declares a future evaluation window in the protocol's native order:

$$\widehat{J}^+_{A;P,M}(u) \subseteq \mathfrak{D}^+_{P,M}(u), \tag{475}$$

where $\mathfrak{D}^+_{P,M}(u)$ is the declared future-order domain of the protocol relative to cutoff u.

The operational window may be specified through:

(a) future sampling indices;
(b) clock-reading ranges;
(c) examination visits;
(d) detector-record sequences;
(e) calendar or scheduling conventions;
(f) or another protocol-defined order.

The operational window is not automatically identical with an ontic cosmic-stage subset:

$$\widehat{J}^+_{A;P,M}(u) \not\equiv J_A^+(s_\star). \tag{476}$$

Any transfer between them requires a separately validated record-to-stage or order-preserving bridge.

Prediction does not actualize the future

A predictive statement made at cutoff u does not cause, create, or make attained the predicted physical outcome.

Define $\mathrm{OutcomeAttainedBy}_{P,M}(Y_A; u)$ as the protocol-relative proposition that accepted evidence available no later than cutoff u warrants actual attainment of the declared outcome. Then

$$\mathrm{Predicted}_{P,M}(Y_A; \widehat{J}^+) \not\Rightarrow \mathrm{OutcomeAttainedBy}_{P,M}(Y_A; u). \tag{477}$$

Prediction is a model-conditioned claim concerning a possible or expected later outcome.

It does not:

(i) insert a later stage into the attained cosmic domain;
(ii) move the bearer into the future;
(iii) determine the fixed cosmic ordering;
(iv) or cause the predicted physical realization.

15.7 Distinct predictive outcomes

Functional failure, identity ending, and successor formation are different predictive targets.

At the complete-history ontic level, define

$$Y_{\mathrm{fail}}^{J+}(A,\kappa) := \mathbf{1}\left[\exists v \in J_A^+(s_\star) \cap I_A \ \ \mathrm{FunctionalFailure}_{A,\kappa}(v)\right]. \tag{478}$$

Define the identity-ending target by

$$Y_{\mathrm{end}}^{J+}(A) := \mathbf{1}\left[\exists v \in J_A^+(s_\star) \ \ \mathrm{End}_A(v)\right]. \tag{479}$$

Where a declared successor set $\mathcal{Q}$ is under investigation, define

$$Y_{\mathrm{succ}}^{J+}(A,\mathcal{Q}) := \mathbf{1}\left[\varnothing \neq \mathcal{Q} \subseteq \mathcal{U}_{\mathrm{phys}} \wedge \exists e \in J_A^+(s_\star)\ \forall B \in \mathcal{Q} \ \ \mathrm{SuccAt}(A,B;e)\right]. \tag{480}$$

The successor target establishes the declared direct-successor relations from A; it does not exclude additional productive predecessors or unlisted successors unless a separate completeness warrant is supplied.

These outcomes must not be collapsed:

$$Y_{\mathrm{fail}}^{J+}(A,\kappa) = 1 \not\Rightarrow Y_{\mathrm{end}}^{J+}(A) = 1. \tag{481}$$

Likewise, prediction of identity ending does not by itself identify the successor set without the required transformation and production warrants.

Boundary-window outcomes

A predictive protocol may be able to estimate an ending or formation window without assigning one exact common cosmic stage.

In that case, the target must be expressed as a protocol-defined boundary-window outcome:

$$\mathrm{PredictedBoundaryWindow}_{P,M}\left(e_A \in W_A^{\mathrm{end}}\right). \tag{482}$$

The window does not replace the unique ontic ending member.

It represents the resolution supported by the prediction model and future evaluation protocol.

15.8 No future-data leakage

Every predictor, reconstruction, calibration rule, feature-selection operation, and model-selection decision must use only information available at or before the declared cutoff u.

Let

$$D_{\mathrm{pre}}(u)$$

be the admissible pre-cutoff data domain and

$$D_{\mathrm{future}}$$

the future evaluation data.

A valid predictive construction requires

$$\boxed{D_{\mathrm{train}} \subseteq D_{\mathrm{pre}}(u), \qquad D_{\mathrm{test}} = D_{\mathrm{future}}, \qquad D_{\mathrm{train}} \cap D_{\mathrm{test}} = \varnothing}. \tag{483}$$

A preregistered validation design may partition the pre-cutoff data for training and tuning, but no future target outcome or post-cutoff information may enter model construction, preprocessing, feature selection, threshold choice, or model selection.

Records from the future target window must not enter:

(a) feature construction;
(b) historical reconstruction;
(c) parameter tuning;
(d) model selection;
(e) threshold choice;
(f) or preprocessing decisions.

Otherwise, the reported performance is not a valid prospective prediction. In later formulas, $\mathrm{PredictionStudyAdmissible}_{P,M}$ abbreviates satisfaction of the declared cutoff, no-leakage, target, bearer-identity, predeclaration, comparison, and uncertainty conditions stated in this section.

15.9 Common baseline information

Let the common baseline information be

$$\mathcal{Z}_{A;P,M}(u) := \left(\mathfrak{K}_A, \widehat{\mathcal{G}}_{A;P,M}(u), D_A\right), \tag{484}$$

where:

(i) $\mathfrak{K}_A$ contains declared class-level information;
(ii) $\widehat{\mathcal{G}}_{A;P,M}(u)$ contains the reconstructed cutoff configuration;
(iii) and D_A contains the declared data-quality, calibration, uncertainty, and admissibility conditions.

The same baseline must be supplied to the compared models unless a predeclared design states and justifies a different comparison.

15.10 Class-only model

Define the class-only model by

$$M_{\text{class}} := \mathfrak{M}_0\left(\mathcal{Z}_{A;P,M}(u); D_{\text{train}}\right). \tag{485}$$

This model uses the declared class and cutoff information but does not use the reconstructed ordered individual history as an additional input.

It supplies an external nonhistorical benchmark.

15.11 History-informed model

Define the history-informed model by

$$M_{\text{hist}} := \mathfrak{M}_1\left(\mathcal{Z}_{A;P,M}(u), \widehat{\mathcal{H}}^{\leq u}_{A;P,M}; D_{\text{train}}\right). \tag{486}$$

This model receives the same baseline information together with the reconstructed individual history.

Its performance tests whether historical information contributes to the declared prediction under the adopted architecture and data conditions.

15.12 History-ablation model

Define a preregistered history-ablation operation

$$\mathcal{A}\left(\widehat{\mathcal{H}}^{\leq u}_{A;P,M}\right) \tag{487}$$

that removes, replaces, or order-disrupts the historical input while preserving the history-capable model architecture, tuning budget, cutoff, and evaluation protocol.

The ablation model is

$$M_{\text{abl}} := \mathfrak{M}_1\left(\mathcal{Z}_{A;P,M}(u), \mathcal{A}\left(\widehat{\mathcal{H}}^{\leq u}_{A;P,M}\right); D_{\text{train}}\right). \tag{488}$$

The class-only comparison and the ablation comparison answer different questions.

The class-only model supplies an external benchmark. The ablation model tests the incremental contribution of ordered historical information within a fixed history-capable architecture.

15.13 Predictive comparison

For a predeclared higher-is-better score, define

$$\Delta_{\text{pred}} := \text{Score}\left(M_{\text{hist}}; D_{\text{test}}\right) - \text{Score}\left(M_{\text{class}}; D_{\text{test}}\right), \tag{489}$$

and define the architecture-controlled historical contribution by

$$\Delta_{\text{hist}} := \text{Score}\left(M_{\text{hist}}; D_{\text{test}}\right) - \text{Score}\left(M_{\text{abl}}; D_{\text{test}}\right). \tag{490}$$

The first difference evaluates the history-informed model against a nonhistorical benchmark.

The second evaluates whether the ordered historical input contributes under the same model architecture.

15.14 Predeclared decision rule

A specific predictive contribution from individual history is accepted only under a decision rule fixed before test-outcome inspection.

For example,

$$\Delta_{\text{hist}} > \delta_{\text{hist}}, \qquad \delta_{\text{hist}} \geq 0, \tag{491}$$

together with an uncertainty analysis appropriate to the score, sampling design, target prevalence, and model-selection procedure.

The threshold, score, uncertainty procedure, and model-comparison rules must not be selected after observing the test results.

Interpretation of positive predictive contribution

Where the declared rule is satisfied, the warranted conclusion is restricted:

$$\begin{aligned} &\Delta_{\text{hist}} > \delta_{\text{hist}} \wedge \text{PredictionStudyAdmissible}_{P,M} \\ &\quad \Longrightarrow \text{HistoryContributesPredictively}_{P,M}(A, Y_A; \widehat{J}^{+}). \end{aligned} \tag{492}$$

This conclusion does not establish that:

(i) the reconstruction equals the complete ontic history;
(ii) every historical feature is causally relevant;
(iii) the model uniquely establishes CMA or UCC;
(iv) the future outcome is inevitable;
(v) or the exact stage of the outcome has been identified.

Negative and inconclusive predictive results

Failure of the history-informed model to outperform the comparison models does not prove that the bearer lacks a physical history or that history has no ontic relevance.

A negative result may reflect:

(a) inadequate historical reconstruction;
(b) inappropriate variables;
(c) insufficient sample size;
(d) weak model architecture;
(e) excessive uncertainty;
(f) poor target definition;
(g) or absence of predictive contribution in the tested domain.

The result must be classified according to the predeclared decision rule as supportive, adverse, or inconclusive for the restricted predictive claim.

It does not alter the actual history of the bearer.

Exact-stage restraint in prediction

Even a highly accurate prediction of a future outcome does not automatically identify its exact common cosmic stage.

Let $\mathcal{C}^{\text{pred}}_{A,Y_A;\widehat{J}^+}$ denote the fully typed claim that the prediction identifies one exact common cosmic stage. Therefore,

$$\text{AccuratePrediction}_{P,M}(A, Y_A; \widehat{J}^+) \not\Rightarrow \text{WarrantedUniqueStageAssignment}_{P,M}\left(\mathcal{C}^{\text{pred}}_{A,Y_A;\widehat{J}^+}\right). \tag{493}$$

The prediction may identify:

(i) an operational record range;
(ii) a clock-output interval;
(iii) a calendar window;
(iv) an ordered examination window;
(v) or a model-conditioned candidate-stage set.

None becomes a unique common cosmic stage without an additional validated bridge.

Prediction and the fixed cosmic order

Prediction neither determines nor modifies the cosmic ordering.

The earlier–later relation remains

$$\prec_C,$$

independently of whether an outcome is correctly predicted, incorrectly predicted, or not predicted.

A prediction model may represent order, estimate record intervals, and assign probabilities. It does not create lateness, move stages, or produce the succession of the cosmic domain.

Cross-domain applicability

The predictive architecture is bearer-general but not mechanism-general.

It may be applied to:

(i) biological organisms;
(ii) patients and medical systems;
(iii) molecular and genetic systems;
(iv) mechanical devices;
(v) materials and structures;
(vi) ecological systems;
(vii) stars and other astrophysical bearers;

(viii) or social and technological composite systems,

only where the relevant bearer criterion, state variables, records, mechanisms, and outcome definitions are independently declared.

Success in one domain does not validate the same identity criterion or mechanism in another domain.

16. Empirical Access, Restricted Testability, and Evidential Architecture

16.1 Test-status discipline

CMA and UCC possess universal ontological scope.

A finite experiment, observation series, or reconstruction study does not directly inspect:

(i) every physical bearer;
(ii) every actual common cosmic stage;
(iii) every component of one bearer's complete physical state;
(iv) every possible physical realization mechanism;
(v) or every record and access channel relevant to the claim.

The empirical programme therefore tests restricted hypotheses and restricted empirical consequences.

It does not convert CMA or UCC into finite stage-by-stage experimental propositions.

The governing distinction is

$$\boxed{\mathrm{UniversalOntologicalClaim} \not\equiv \mathrm{RestrictedOperationalHypothesis}\,.} \tag{494}$$

A restricted study may support, challenge, or leave unresolved an application of the framework without exhausting the universal quantifiers.

The five-layer empirical architecture

A valid study must distinguish five layers:

(1) a preregistered restricted operational hypothesis;
(2) study admissibility;
(3) accepted records and realized planned comparisons;
(4) a declared decision rule;
(5) and a restricted evidential conclusion.

These layers have different logical types.

Neither the records nor the study qualifications are themselves the hypothesis, decision, or conclusion.

The architecture has the form

$$
\boxed{\begin{aligned}\text{Preregistered hypothesis} + \text{admissibility}\\ + \text{accepted evidence} + \text{decision rule}\\ \Longrightarrow \text{restricted conclusion.}\end{aligned}} \tag{495}
$$

No conclusion may be inserted into the hypothesis after the records have been inspected.

16.2 Protocol and record-channel declaration

Let P be a declared protocol.

For a single-channel protocol, let

$$
D(P) \tag{496}
$$

be the detector or record channel selected by P, and let

$$
\mathfrak{R}_P := \mathfrak{R}_{D(P)} \tag{497}
$$

be its accepted record domain.

The channel is not an undeclared free parameter.

Changing the detector, assay, wavelength range, sampling method, processing route, or record source produces a different protocol instance unless the multichannel relation was preregistered.

For a multichannel study, define a declared family

$$
\mathbf{P} = (P_d)_{d \in \mathcal{D}_P}, \qquad D(P_d) = d, \tag{498}
$$

together with a preregistered cross-channel validity and combination rule.

No family-level conclusion follows from several channels merely because they were all used.

16.3 Preregistered bearer and identity scope

Before evidence inspection, the study must declare:

(1) the physical bearer A;
(2) the identity criterion used for A;
(3) the evidential warrant for attributing the records to that bearer;
(4) the operationally represented identity window;
(5) the variables or state components under investigation;
(6) the protocol and record channels;
(7) the sampling or comparison domain;
(8) the model and auxiliary assumptions;
(9) the sensitivity and uncertainty budget;
(10) the decision rule;
(11) and the outcome that would count against the hypothesis.

The operationally estimated bearer window may be written

$$\widehat{I}_{A;P,M}. \tag{499}$$

It is not presumed to equal the complete ontic identity domain:

$$\widehat{I}_{A;P,M} \not\equiv I_A. \tag{500}$$

The study must not presume exhaustive knowledge of I_A merely because the bearer has been observed through a finite record series.

16.4 Operational sampling and comparison indices

Let

$$\mathcal{I}_P \tag{501}$$

be the protocol's sampling or record-index domain.

Let

$$\mathcal{J}_P \subseteq \mathcal{I}_P \times \mathcal{I}_P \tag{502}$$

be the preregistered set of planned comparison pairs.

The domain $\mathcal{I}_P$ may be based on:

(a) sampling order;
(b) record sequence;
(c) examination visits;
(d) clock readings;
(e) exposure numbers;
(f) detector frames;
(g) or another declared operational order.

Neither $\mathcal{I}_P$ nor $\mathcal{J}_P$ is automatically a cosmic stage domain.

16.5 Restricted operational no-stasis hypothesis

Let V be the selected variable family, let $d_{M,V}$ be the declared comparison functional, and let $\varepsilon \geq 0$ be the accepted resolution threshold.

For preregistered target outcomes O_i^*, define the restricted operational no-stasis hypothesis by

$$\begin{aligned} &H^{\mathrm{OpNS}}_{A;P,M,V,\varepsilon,\mathcal{J}_P} : \\ &\qquad \exists (i,j) \in \mathcal{J}_P \left[i \neq j \wedge d_{M,V}\left(O_i^*, O_j^*\right) > \varepsilon \right]. \end{aligned} \tag{503}$$

The target outcomes are fixed before the corresponding records are inspected.

The hypothesis concerns a detectable difference under the declared variables, protocol, model, threshold, and comparison plan.

It is not an ontological restatement of UCC.

Therefore,

$$H^{\mathrm{OpNS}}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \not\equiv \mathrm{UCC}(A). \tag{504}$$

16.6 Study admissibility

Study admissibility is a separate proposition.

Define

$$\begin{aligned}
&\mathrm{AdmissibleStudy}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\
&\quad \Longleftrightarrow \mathrm{StudyQualified}_{P,M}(A) \\
&\qquad \wedge \mathrm{IdentityWarrant}_{A;P,M} \\
&\qquad \wedge \mathrm{ProtocolAdequacy}_{A;P} \\
&\qquad \wedge \mathrm{ModelScopeDeclared}_{A;M,V} \\
&\qquad \wedge \mathrm{SensitivityAdequate}_{A;P,M,V,\varepsilon} \\
&\qquad \wedge \mathrm{ConfoundersControlled}_{A;P,M,V}\,.
\end{aligned} \tag{505}$$

Admissibility does not assert the hypothesis and does not predetermine the result:

$$\mathrm{AdmissibleStudy} \not\Rightarrow \mathrm{Support}\,. \tag{506}$$

It states only that the study is sufficiently qualified for its declared restricted decision architecture.

16.7 Accepted evidence set

Define the accepted evidence set by

$$\mathcal{E}_{A;P,M,V} := \Big\{ r \in \mathfrak{R}_P \mid \mathrm{AcceptedRecord}_{A;P,M,V}(r) \Big\}\,. \tag{507}$$

Acceptance requires at least:

(i) record-domain membership;
(ii) record integrity;
(iii) valid provenance;
(iv) bearer attribution;
(v) protocol compliance;
(vi) and satisfaction of the preregistered quality conditions.

A record that fails these conditions may remain a physical record but does not enter the confirmatory evidence set.

16.8 Accepted realization of the comparison plan

Let

$$\iota_P : \mathfrak{R}_P \dashrightarrow \mathcal{I}_P \tag{508}$$

assign an accepted record its preregistered sampling or comparison index where that index is defined.

Define the accepted realization of the preregistered comparison plan by

$$\begin{aligned}\mathfrak{P}^{\mathrm{acc|plan}}_{A;P,M,V,\mathcal{J}_P} := \{(r_i, r_j) \in \mathcal{E}^2_{A;P,M,V} \;\mid\; & r_i \neq r_j \\ & \wedge r_i, r_j \in \mathrm{Dom}(\iota_P) \\ & \wedge (\iota_P(r_i), \iota_P(r_j)) \in \mathcal{J}_P \\ & \wedge \mathrm{ValidComparison}_{A;P,M,V}(r_i, r_j)\}.\end{aligned} \tag{509}$$

Post hoc comparisons may be reported as exploratory results.

They do not enter the preregistered confirmatory decision unless the protocol expressly authorized them.

Observed operational difference

Define the observed difference proposition by

$$\begin{aligned}&\mathrm{ObservedDifference}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\ &\iff \exists (r_i, r_j) \in \mathfrak{P}^{\mathrm{acc|plan}}_{A;P,M,V,\mathcal{J}_P} \\ &\qquad d_{M,V}\left(O(r_i), O(r_j)\right) > \varepsilon.\end{aligned} \tag{510}$$

This is a protocol-relative operational proposition.

It is not yet an unrestricted ontological conclusion about the complete bearer state.

16.9 Operational stasis

Operational stasis requires at least one valid planned comparison and no accepted difference exceeding the threshold:

$$\begin{aligned}&\mathrm{OperationalStasis}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\ &\iff \mathfrak{P}^{\mathrm{acc|plan}}_{A;P,M,V,\mathcal{J}_P} \neq \varnothing \\ &\quad \wedge \forall (r_i, r_j) \in \mathfrak{P}^{\mathrm{acc|plan}}_{A;P,M,V,\mathcal{J}_P}, \\ &\qquad d_{M,V}\left(O(r_i), O(r_j)\right) \leq \varepsilon.\end{aligned} \tag{511}$$

Operational stasis means only that the selected accepted comparisons remain equivalent within the declared threshold.

It does not entail complete physical stasis:

$$\boxed{\mathrm{OperationalStasis}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \nRightarrow \mathrm{CompletePhysicalStasis}(A).} \tag{512}$$

16.10 Empty comparison sets

Where no valid planned comparison survives the quality and attribution requirements,

$$\mathfrak{P}^{\mathrm{acc|plan}}_{A;P,M,V,\mathcal{J}_P} = \varnothing, \tag{513}$$

the result is not support and is not adversity.

It is inconclusive:

$$\mathfrak{P}^{\mathrm{acc|plan}} = \varnothing \Longrightarrow \mathrm{Decision} = \mathsf{inconclusive}. \tag{514}$$

This prevents missing, invalid, or unperformed comparisons from being silently treated as null differences.

Declared decision rule

The decision rule must be fixed before outcome interpretation.

Define

$$\begin{aligned} &\mathrm{DecisionRule}_{A;P,M,V,\varepsilon,\mathcal{J}_P}\left(\mathcal{E}_{A;P,M,V}, \mathfrak{P}^{\mathrm{acc|plan}}_{A;P,M,V,\mathcal{J}_P}\right) \\ &\quad \in \{\mathsf{support}, \mathsf{adverse}, \mathsf{inconclusive}\}. \end{aligned} \tag{515}$$

The rule must specify how uncertainty, invalid comparisons, missing records, conflicting channels, and borderline values are handled.

It may not be rewritten solely because the observed result is unfavourable.

Restricted study conclusion

For an admissible study, define the study conclusion as the output of the declared rule:

$$\begin{aligned} &\mathrm{AdmissibleStudy}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\ &\quad \Longrightarrow \mathrm{StudyConclusion}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\ &\quad\quad = \mathrm{DecisionRule}_{A;P,M,V,\varepsilon,\mathcal{J}_P}\left(\mathcal{E}_{A;P,M,V}, \mathfrak{P}^{\mathrm{acc|plan}}_{A;P,M,V,\mathcal{J}_P}\right). \end{aligned} \tag{516}$$

The conclusion remains restricted to:

(a) the declared bearer and identity warrant;
(b) the selected variables;
(c) the protocol and channels;
(d) the comparison plan;
(e) the model;
(f) the sensitivity and uncertainty;
(g) and the tested operational domain.

16.11 Positive record-level witness

Let

$$\text{AcceptedBearerRecord}_{A;P,M}(r) \tag{517}$$

mean that $r \in \mathfrak{R}_P$ is an accepted record validly attributed to bearer A.

Define a same-bearer record pair by

$$\begin{aligned} &\text{SameBearerRecords}_{A;P,M}(r_1, r_2) \\ &\quad \Longleftrightarrow r_1 \neq r_2 \\ &\qquad \wedge \text{AcceptedBearerRecord}_{A;P,M}(r_1) \\ &\qquad \wedge \text{AcceptedBearerRecord}_{A;P,M}(r_2). \end{aligned} \tag{518}$$

For bearer component k, comparison criterion Γ, and channel $D(P)$, define a positive witness by

$$\begin{aligned} &\text{PositiveWitness}^{\Gamma}_{A,k;P,M}(r_1, r_2) \\ &\quad \Longleftrightarrow \text{SameBearerRecords}_{A;P,M}(r_1, r_2) \\ &\qquad \wedge \text{DeclaredCriterion}_{A,k;P}(\Gamma) \\ &\qquad \wedge \text{ValidRecordAttribution}_{A,k;P,M}(r_1, r_2) \\ &\qquad \wedge d_{P,D(P)}\left(O_{A,k,P}(r_1), O_{A,k,P}(r_2)\right) > \varepsilon_{A,k,P,D(P)}. \end{aligned} \tag{519}$$

The witness does not reduce to an arbitrary numerical difference.

It requires distinct accepted records, valid same-bearer attribution, a declared component, and a resolved difference.

16.12 Restricted witness warrant

A positive witness may warrant a criterion-relative bearer difference:

$$\begin{aligned} &\text{PositiveWitness}^{\Gamma}_{A,k;P,M}(r_1, r_2) \\ &\quad \Longrightarrow \text{Warrant}_{P,M}\left[\text{NoticeableComponentDifference}^{\Gamma}_{A,k}(r_1, r_2)\right]. \end{aligned} \tag{520}$$

If the bearer-level criterion treats a valid difference in component k as sufficient for non-equivalence, then

$$\begin{aligned} &\text{PositiveWitness}^{\Gamma}_{A,k;P,M}(r_1, r_2) \\ &\quad \Longrightarrow \text{Warrant}_{P,M}\left[\text{NoticeableBearerDifference}^{\Gamma}_{A}(r_1, r_2)\right]. \end{aligned} \tag{521}$$

Both conclusions are protocol-relative evidential propositions.

They are not ontic stage predicates.

Restricted empirical witness

An admissible study with an accepted attributed difference may warrant a restricted empirical witness:

$$
\begin{aligned}
&\text{AdmissibleStudy}_{A;P,M,V,\varepsilon,\mathcal{J}_P}\\
&\wedge \text{ObservedDifference}_{A;P,M,V,\varepsilon,\mathcal{J}_P}\\
&\wedge \text{ValidBearerAttribution}_{A;P,M}\\
&\qquad \Longrightarrow \text{RestrictedEmpiricalWitness}_{A;P,M,V,\varepsilon}\,.
\end{aligned}
\tag{522}
$$

The record-level positive witness and the study-level restricted witness must not be conflated.

The first concerns one comparison.

The second records the evidential conclusion produced by the complete declared study architecture.

Stagewise and exact-stage restraints

A restricted witness has neither of the following consequences:

$$
\begin{aligned}
&\text{RestrictedEmpiricalWitness}_{A;P,M,V,\varepsilon} \not\Rightarrow \text{StagewiseExhaustiveTest}_{A;P,M}(I_A),\\
&\text{RestrictedEmpiricalWitness}_{A;P,M,V,\varepsilon} \not\Rightarrow \text{ExactCosmicStageIdentified}_{A;P,M}(\chi).
\end{aligned}
\tag{523}
$$

The witness does not establish that the protocol accessed every common stage applicable to the bearer.

It does not turn a record index, coordinate, clock reading, threshold crossing, or examination endpoint into the exact stage of the underlying realization.

Four levels of empirical claim

The empirical programme distinguishes:

(i) one physical difference in one identified bearer;
(ii) continuing change in that bearer across a declared operational domain;
(iii) continuing change across a defined physical class;
(iv) universal change continuity across all physical bearers.

Each level carries a different burden.

Evidence for one molecule does not automatically establish change in the whole cell, organism, lineage, or species.

Evidence for one component of a composite bearer does not automatically establish a bearer-complete claim.

Evidence across several classes does not deductively exhaust the universal quantifier.

Coverage dimensions

Coverage has at least the following dimensions:

(a) *component coverage*: which parts, fields, relations, or scales are accessed;
(b) *spatial coverage*: which regions, surfaces, cells, tissues, or source areas are sampled;
(c) *operational-order coverage*: which sampling windows, comparisons, and gaps are included;
(d) *mechanism coverage*: which physical routes could produce realization outside the measured channels;
(e) *identity coverage*: whether the same bearer is warranted across the claimed domain;

(f) and *attribution coverage*: whether the accepted records can be assigned to the stated bearer and component.

A null result in one channel supports only a bounded statement about that channel and coverage.

Physical variables and access variables

Physical variables belong to the bearer.

They may include:

(i) composition;
(ii) structure;
(iii) fields;
(iv) spatial relations;
(v) molecular sequences;
(vi) energy distributions;
(vii) interactions;
(viii) correlations;
(ix) and physical processes.

Access variables belong to the measurement chain.

They may include:

(i) sensitivity;
(ii) sampling;
(iii) integration;
(iv) calibration;
(v) propagation;
(vi) alignment;
(vii) reconstruction assumptions;
(viii) detector response;
(ix) and selection rules.

An access limitation must not be reported as a bearer property.

Independent evidential channels

Convergent evidence gains strength where channels depend upon physically and methodologically differentiated routes.

Independence is not established merely because the instruments possess different names.

The analysis must declare shared:

(a) samples;
(b) preparation procedures;
(c) calibration chains;
(d) data sources;
(e) model assumptions;
(f) processing software;

(g) propagation models;
(h) and systematic errors.

Distinct channels may remain strongly correlated through one shared failure mode.

Outcome classes

A restricted study may produce:

(a) *validated difference*: one or more accepted witnesses support criterion-relative bearer non-equivalence;
(b) *bounded equivalence*: the selected variables remain equivalent within the declared sensitivity and coverage;
(c) *unresolved result*: identity, attribution, data, model, or coverage is insufficient;
(d) *adverse restricted result*: an admissible null or contrary result defeats the preregistered operational hypothesis.

Bounded equivalence is not complete physical identity.

An adverse restricted result is scientifically consequential but remains limited to the hypothesis actually tested.

Adverse-study admissibility

An adverse conclusion requires stronger qualifications than a positive difference witness.

Define

$$\begin{aligned}
&\mathrm{AdverseAdmissible}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\
&\quad \iff \mathrm{AdmissibleStudy}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\
&\qquad \wedge \mathrm{IdentityPersistenceWarrant}_{A;P,M} \\
&\qquad \wedge \mathrm{BearerCoverageAdequate}_{A;P,M,V,\varepsilon} \\
&\qquad \wedge \mathrm{PlannedComparisonCoverageAdequate}_{A;P,M,\mathcal{J}_P} \\
&\qquad \wedge \mathrm{InferenceValidated}_{A;P,M,V}\,.
\end{aligned} \tag{524}$$

These are qualifications for interpreting the null or contrary result.

They are not the adverse conclusion itself.

16.13 Decision compatibility

The decision rule must remain compatible with the operational evidence while retaining an inconclusive option.

Thus,

$$\begin{aligned}
&\mathrm{ObservedDifference}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\
&\wedge \mathrm{AdmissibleStudy}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\
&\qquad \implies \mathrm{Decision} \in \{\mathsf{support}, \mathsf{inconclusive}\}\,,
\end{aligned} \tag{525}$$

and

$$
\begin{aligned}
&\text{OperationalStasis}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\
&\wedge \text{AdverseAdmissible}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\
&\quad \Longrightarrow \text{Decision} \in \{\mathsf{adverse}, \mathsf{inconclusive}\}\,.
\end{aligned}
\tag{526}
$$

Unresolved uncertainty prevents a forced binary result.

Restricted adverse conclusion

For the preregistered operational hypothesis,

$$
\begin{aligned}
&\text{AdverseAdmissible}_{A;P,M,V,\varepsilon,\mathcal{J}_P} \\
&\wedge \text{DecisionRule}_{A;P,M,V,\varepsilon,\mathcal{J}_P} = \mathsf{adverse} \\
&\quad \Longrightarrow \text{StudyConclusion}_{A;P,M,V,\varepsilon,\mathcal{J}_P} = \mathsf{adverse.}
\end{aligned}
\tag{527}
$$

This conclusion is adverse to the restricted hypothesis.

It is not by itself a proof that positive physical realization ceased at an ontic member of the bearer's identity domain.

Cumulative empirical pressure

Repeated adverse results may increase pressure upon:

(i) the selected application bridge;
(ii) the bearer or identity classification;
(iii) the auxiliary model;
(iv) the class-level continuity claim;
(v) or the unrestricted foundational proposition.

The force of the pressure increases with:

(a) independent protocols;
(b) broader component and mechanism coverage;
(c) higher sensitivity;
(d) stronger identity warrant;
(e) controlled confounding;
(f) and successful replication.

Repeated adversity is not automatically the same as complete-stasis warrant, but it may not be ignored.

16.14 The logical falsifier of bearer-relative UCC

For a physical bearer A, the exact classical negation condition is

$$
\boxed{
\begin{aligned}
&\text{PhysicalSystem}(A) \Longrightarrow \Big[\neg\,\text{UCC}(A) \Longleftrightarrow \exists s \in I_A\Big(\text{LaterInHistory}_A(s) \\
&\qquad\qquad\qquad\qquad\qquad\qquad \wedge \neg\,\text{PhysReal}^+_A(s)\Big)\Big].
\end{aligned}
}
\tag{528}
$$

This is an ontological contradiction condition.

It is not an inference from a finite null record.

Because UCC is derived from CMA for a bearer at an applicable common stage, one warranted counterinstance would also contradict CMA there:

$$\begin{aligned} A \in \mathcal{S}_{\mathrm{phys}}(s) \wedge \mathrm{LaterInHistory}_A(s) \wedge \neg\,\mathrm{PhysReal}_A^{+}(s) \\ \implies \neg\,\mathrm{CMA}(s). \end{aligned} \tag{529}$$

16.15 Scientific rejection rule

Let Π be a preregistered family of independent protocols.

Define

$$\mathrm{BearerCompleteStasisWarrant}_{\Pi}(A, J) \tag{530}$$

as a strengthened, claim-relative evidential status requiring the declared protocol family to satisfy its preregistered bearer, component, mechanism, sensitivity, sampling, identity, and inference coverage.

Define separately

$$\mathrm{NontrivialHistoryWarrant}_{\Pi}(A, J) \tag{531}$$

as warrant for at least one valid ordered same-bearer comparison within the represented history.

A scientific rejection rule may then be stated as

$$\boxed{\begin{aligned} &\mathrm{BearerCompleteStasisWarrant}_{\Pi}(A, J) \\ &\wedge \mathrm{NontrivialHistoryWarrant}_{\Pi}(A, J) \\ &\qquad \implies \mathrm{Reject}_{\Pi}\left(\mathrm{UCC}(A)\right). \end{aligned}} \tag{532}$$

The operator Reject_{Π} records a scientifically warranted and revisable decision.

It is not itself identical with the ontological proposition $\neg\,\mathrm{UCC}(A)$.

Repeated adversity is not automatic rejection

Repeated adverse studies do not automatically establish both strengthened warrants:

$$\begin{aligned} \mathrm{RepeatedAdverse}_{\Pi}(A, J) \not\Rightarrow\ & \mathrm{BearerCompleteStasisWarrant}_{\Pi}(A, J) \\ & \wedge \mathrm{NontrivialHistoryWarrant}_{\Pi}(A, J). \end{aligned} \tag{533}$$

They nevertheless require review of:

(i) bearer attribution;
(ii) identity persistence;
(iii) auxiliary assumptions;
(iv) instrument and model adequacy;

(v) empirical scope;
(vi) and the foundational claim.

No post hoc hidden-change rescue

After the bearer, identity criterion, channels, sensitivity, sampling, auxiliary assumptions, and decision rule have been preregistered, an adverse result may not be converted into confirmation by introducing an unspecified hidden change solely because the outcome is adverse.

A newly proposed physical route must be formulated as a new auxiliary hypothesis with:

(a) an identified bearer or physical factor;
(b) a specified mechanism;
(c) predicted record consequences;
(d) a prospective discrimination procedure;
(e) and an independently declared decision rule.

The new hypothesis may motivate a later study.

It does not retroactively erase the evidential status of the completed protocol.

Underdetermination is not confirmation

Where no admissible physical route exists for discriminating positive bearer realization from complete stasis under the declared claim,

$$\begin{aligned} &\neg\,\mathrm{AdmissibleDiscriminationRoute}_{\Pi}(A,J) \\ &\qquad\Longrightarrow \mathrm{EmpiricallyUnderdetermined}_{\Pi}\left(\mathrm{UCC}(A);J\right). \end{aligned} \tag{534}$$

The result is not:

$$\mathrm{UCC}(A)$$

and is not:

$$\neg\,\mathrm{UCC}(A).$$

Absence of a discrimination route is a limitation on present empirical closure.

It is not positive evidence for the axiom.

Application-specific realization bridge

Notation alone does not create a universal bridge from records to physical realization.

For each application class κ, the bridge must declare:

(1) the bearer and numerical-identity criterion;
(2) the physical state or occurrence representation;
(3) the domain in which that representation is valid;
(4) sufficient positive-witness conditions;
(5) claim-relative complete-stasis conditions;

(6) sensitivity, sampling, uncertainty, and coverage;
(7) and the inferential rule connecting evidence to the target claim.

Schematically,

$$\begin{aligned} &\mathrm{ValidatedRealizationBridge}_{\kappa;P,M}(A,J) \\ &\wedge \mathrm{ApplicationEvidence}_{\kappa;P,M}(A,J) \\ &\quad\Longrightarrow \mathrm{Warrant}_{\kappa;P,M}\left[\mathcal{C}_\kappa(A,J)\right]. \end{aligned} \tag{535}$$

Here $\mathcal{C}_\kappa(A,J)$ is the positive-realization or claim-relative complete-stasis proposition fixed before outcome interpretation.

The schema never permits a bare null record to entail

$$\neg\,\mathrm{PhysReal}_A^+(s).$$

Class-level synthesis

A class-level synthesis must state:

(1) the bearer class and its boundaries;
(2) the identity criteria used within the class;
(3) the tested subclasses;
(4) the sampling and exclusion rules;
(5) the physically distinct realization routes;
(6) the independent evidence channels;
(7) the difficult and unresolved candidates;
(8) and the adverse result capable of revising the class claim.

The force of a class synthesis arises from diversity of mechanisms and methods.

It does not arise merely from multiplying similar examples.

16.16 Cross-domain coverage

Let

$$\mathfrak{D}_{\mathrm{cov}} \tag{536}$$

be the explicitly covered bearer classes.

For each class $\mathcal{D} \in \mathfrak{D}_{\mathrm{cov}}$, declare a protocol and model bundle

$$\Pi_{\mathcal{D}} := (P_{\mathcal{D}}, M_{\mathcal{D}})\,. \tag{537}$$

Let

$$\mathbf{\Pi}_{\mathrm{cov}} := (\Pi_{\mathcal{D}})_{\mathcal{D}\in\mathfrak{D}_{\mathrm{cov}}} \tag{538}$$

retain the association between each bearer class and its own protocol and model.

No single record channel or inference model is silently imposed across unlike domains.

Domain-level witness

Define the class-indexed witness proposition by

$$\begin{aligned} \mathcal{W}_{\mathcal{D}}(\Pi_{\mathcal{D}}) \iff & \exists A_{\mathcal{D}} \in \mathcal{D} \\ & \exists k_{\mathcal{D}} \\ & \exists r_{\mathcal{D},1}, r_{\mathcal{D},2} \\ & \text{PositiveWitness}^{\Gamma}_{A_{\mathcal{D}},k_{\mathcal{D}};P_{\mathcal{D}},M_{\mathcal{D}}}(r_{\mathcal{D},1}, r_{\mathcal{D},2}). \end{aligned} \tag{539}$$

One witness establishes an exemplar within the domain.

It does not automatically establish adequate class coverage.

Cross-domain convergence warrant

Define a coverage-qualified cross-domain convergence proposition by

$$\begin{aligned} & \mathcal{W}_{\text{CD}}(\mathfrak{D}_{\text{cov}}; \mathbf{\Pi}_{\text{cov}}) \\ & \quad \iff |\mathfrak{D}_{\text{cov}}| \geq 2 \\ & \qquad \wedge \text{MethodologicalIndependenceAdequate}(\mathbf{\Pi}_{\text{cov}}) \\ & \qquad \wedge \text{CrossDomainCoverageAdequate}(\mathfrak{D}_{\text{cov}}, \mathbf{\Pi}_{\text{cov}}) \\ & \qquad \wedge \forall \mathcal{D} \in \mathfrak{D}_{\text{cov}}, \quad \mathcal{W}_{\mathcal{D}}(\Pi_{\mathcal{D}}). \end{aligned} \tag{540}$$

The methodological-independence condition must examine shared data, sampling frames, instruments, calibration chains, model assumptions, and systematic errors.

Detector nonidentity alone is insufficient.

Cross-domain convergence does not prove universality

A cumulative warrant across covered domains does not deductively exhaust the unrestricted claim:

$$\begin{aligned} & \mathcal{W}^{\text{emp}}_{\text{UCC,covered}}(\mathfrak{D}_{\text{cov}}) \\ & \qquad \not\Rightarrow \forall A\,[\text{PhysicalSystem}(A) \implies \text{UCC}(A)]. \end{aligned} \tag{541}$$

Its force increases with:

(a) bearer-class diversity;
(b) mechanism diversity;
(c) independent access routes;
(d) explicit identity criteria;
(e) adequate sampling;
(f) and serious treatment of difficult candidates.

It remains cumulative empirical support rather than exhaustive quantifier inspection.

Successor evidence within empirical architecture

Evidence for continuing bearer change and evidence for identity-ending transformation are different.

A positive witness of state difference does not by itself establish:

(i) identity ending;
(ii) formation of a successor;
(iii) the identity of any particular successor;
(iv) or an exact transformation stage.

Successor claims require the independent bearer, identity, transformation, production, and outcome warrants established in Section 9.

Cross-domain convergence may support transformation histories without imposing transformation on every bearer change.

Limits on empirical access to CMA and UCC

No bounded protocol directly inspects the complete physical totality at every actual common stage.

A finite positive result supplies a restricted witness or cumulative support.

It does not:

(a) prove the universal quantifier;
(b) identify the first stage at which a manifestation became physically realized;
(c) show that every intervening stage was individually accessed;
(d) or establish complete knowledge of the bearer state.

A finite null result rejects only the declared restricted hypothesis when its preregistered adverse conditions are satisfied.

Even a strong scientific rejection decision and an ontological counterinstance remain propositions of different types.

Measurement-system inclusion

The sample, apparatus, detector, record bearer, observer, and environmental systems remain physical bearers within the universal scope under assessment.

Their inclusion under CMA is a consequence of the axiom's declared scope.

It is not independent evidence proving CMA.

These systems may:

(i) interact;
(ii) influence one another;
(iii) stand in part–whole relations;
(iv) function as composite systems;
(v) and contribute overlapping physical factors.

Their changes and interactions must be included in attribution, calibration, intervention analysis, and uncertainty control where relevant.

16.17 Present empirical status

V29/F9 states a universal foundational position and supplies a systematic program for cumulative empirical assessment. Its measurement, uncertainty, and model-comparison vocabulary is used in the restricted sense represented by established metrological and statistical references [17, 18, 19, 20].

Its empirical architecture includes:

(1) preregistered restricted hypotheses;
(2) explicit bearer and identity criteria;
(3) typed record and evidence domains;
(4) accepted planned comparisons;
(5) positive witnesses;
(6) coverage requirements;
(7) supportive, adverse, and inconclusive outcomes;
(8) exact-stage and stagewise-access restraints;
(9) application-specific realization bridges;
(10) logical counterinstance conditions;
(11) scientific rejection rules;
(12) cross-domain convergence;
(13) and mandatory review under cumulative adversity.

Representative material evidence includes physical aging, memory and rejuvenation effects, accelerated-light exposure standards, dynamic-mechanical testing, and treatment-induced material changes [40, 41, 42, 43, 44, 45]. Representative biological and genetic evidence includes single-molecule dynamics, somatic and germline mutation studies, and persistent mutagenic lesions [57, 46, 47, 48, 49, 50, 51]. Representative geophysical and planetary evidence includes glacier monitoring and planetary-interior observations [52, 53, 54, 55].

The framework does not claim that a finite archive exhausts the universal quantifiers.

It also does not permit evidential limitation to become immunity from revision.

17. Direct Ontological Confrontation with Relativity

17.1 Governing rejection

V29/F9 rejects the relativistic conception of time.

It asserts no compatibility, reconciliation, synthesis, complementary temporal ontology, or division of authority in which relativistic time and ITOF time are treated as two equally valid descriptions of one temporal reality.

The disagreement is foundational. The relativistic formalisms examined in this section are represented by the original special- and general-relativistic works and standard philosophical and dynamical analyses [7, 8, 11, 12, 13, 14, 15, 16].

ITOF defines time as the universal ordering and succession of common cosmic stages in one common cosmic extension:

$$T_{\mathrm{ITOF}} = (\mathcal{S}_C, \prec_C) \,. \tag{542}$$

Relativistic theories instead employ mathematical and geometrical objects including:

(i) temporal and spatial coordinates;
(ii) Lorentzian metrics;
(iii) metric intervals;
(iv) worldlines;
(v) proper-time functionals;
(vi) light-cone and causal classifications;
(vii) spacetime manifolds;
(viii) curvature tensors;
(ix) foliations and hypersurfaces;
(x) and modelled clock and frequency relations.

ITOF does not accept any of those objects as time.

17.2 The categorical type boundary

Let

$$\mathcal{Q}_{\mathrm{rel}} = \bigsqcup_{\tau \in \mathfrak{T}_{\mathrm{rel}}} \mathcal{Q}_{\mathrm{rel}}^{(\tau)} \tag{543}$$

denote the disjoint typed family of relativistic quantities.

Its members may include coordinates, intervals, tensors, functionals, frequency ratios, model events, geometrical surfaces, and predicted instrument outputs.

For every $q \in \mathcal{Q}_{\mathrm{rel}}$,

$$\boxed{q \not\equiv T_{\mathrm{ITOF}}.} \tag{544}$$

More explicitly,

$$\begin{aligned} \mathrm{Type}(T_{\mathrm{ITOF}}) &= \mathsf{UniversalCosmicSuccession}, \\ \mathrm{Type}(x^\mu) &= \mathsf{CoordinateAssignment}, \\ \mathrm{Type}(g_{\mu\nu}) &= \mathsf{LorentzianMetric}, \\ \mathrm{Type}(ds^2) &= \mathsf{MetricInterval}, \\ \mathrm{Type}(\tau[\gamma, g]) &= \mathsf{MetricWorldlineFunctional}. \end{aligned} \tag{545}$$

The difference is not merely terminological.

The objects possess different domains, operations, predicates, and identity conditions.

No numerical agreement, predictive fit, geometrical convention, or customary use of the word “time” supplies an identity bridge between them.

17.3 No type-preserving identity bridge

The governing nonidentity may be stated as

$$\boxed{\forall q \in \mathcal{Q}_{\text{rel}}, \qquad \neg\exists \mathcal{B}_{\text{id}} \ \text{TypePreservingIdentityBridge}\left(q, T_{\text{ITOF}}; \mathcal{B}_{\text{id}}\right).} \tag{546}$$

This proposition states that no declared bridge preserves the meanings and types required to identify a relativistic quantity with ITOF time.

A coordinate does not become the universal cosmic ordering.

A metric interval does not become cosmic succession.

A proper-time functional does not become a private portion of time.

A clock output does not become a quantity of time.

17.4 The scope of the rejection

The rejection contains two distinguishable levels.

The first is an internal type result:

$$q \in \mathcal{Q}_{\text{rel}} \Longrightarrow q \not\equiv T_{\text{ITOF}}. \tag{547}$$

This establishes that relativistic quantities do not possess the type of time under the ITOF definition.

The second is the broader foundational judgment that relativistic temporal ontology misidentifies the physical nature of time by treating coordinates, metric relations, geometrical dimensions, worldline functionals, or clock outcomes as temporal reality.

The internal type result contributes to that broader rejection.

It is not presented as a single formal proof of every mathematical, dynamical, or observational claim made within relativistic physics.

Global ordering and relativistic foliation

Some relativistic spacetime models do not admit a preferred global simultaneity relation or a global foliation under their own geometrical conditions.

ITOF does not convert that model-internal result into proof that no actual universal common-stage ordering exists.

Such a conversion would require an independently established bridge from the model geometry to:

(i) the actuality of $\mathcal{S}_C$;
(ii) membership in $\mathcal{S}_C$;
(iii) the universal ordering $\prec_C$;
(iv) common-stage population;
(v) and bearer-specific physical realization under CMA.

Relativistic formalism does not obtain that bridge by definition.

Conversely, ITOF does not attempt to make its common stages into:

(a) an ADM slicing;
(b) a preferred relativistic foliation;
(c) a family of constant-coordinate hypersurfaces;
(d) a modified Lorentz frame;
(e) or an alternative spacetime geometry.

The common cosmic ordering is a primitive ontological commitment, not a geometrical reconstruction inside relativity.

Foundational disagreement rather than reconciliation

Where a relativistic model denies, omits, or cannot represent one universal actual ordering of common stages, the disagreement with ITOF is not removed by choosing a convenient coordinate system.

Nor is it removed by asserting that both theories merely describe different aspects of time.

The positions concern incompatible temporal identifications:

$$\boxed{\begin{array}{c}\text{ITOF time} = \text{universal cosmic ordering and succession,}\\ \text{relativistic temporal quantities} = \text{coordinates, metrics, or worldline-dependent quantities.}\end{array}} \tag{548}$$

ITOF rejects the second line as an identification of the physical nature of time.

17.5 Model-bounded calculational adequacy

A mathematical model may successfully calculate or approximate selected physical records without defining the ontology of time.

Let M_{rel} be a relativistic model, P a protocol, $\mathcal{D}_{\mathrm{data}}$ a dataset, and q a declared relativistic quantity.

Then

$$\begin{aligned} &q \in \mathcal{Q}_{\mathrm{rel}} \\ &\wedge \mathrm{ApproximateFit}\left(M_{\mathrm{rel}}, P, \mathcal{D}_{\mathrm{data}}, q\right) \\ &\quad \Longrightarrow \mathrm{ModelBoundedCalculationalAdequacy}\left(q; M_{\mathrm{rel}}, P, \mathcal{D}_{\mathrm{data}}\right). \end{aligned} \tag{549}$$

The conclusion is restricted to the model, records, protocol, variables, and accepted tolerance.

It does not entail:

$$\mathrm{ModelBoundedCalculationalAdequacy} \not\Rightarrow q \equiv T_{\mathrm{ITOF}}. \tag{550}$$

It also does not establish that the complete physical ontology represented by the model is correct.

Observations are not rejected with the ontology

ITOF does not deny that physical experiments produce:

(i) differential clock readings;
(ii) frequency-shift records;
(iii) signal-propagation records;
(iv) trajectory-dependent outcomes;
(v) navigation corrections;
(vi) particle-decay records;
(vii) or other measurable physical differences.

It rejects the inference that such outcomes establish:

(a) different quantities of time;
(b) different rates of time;
(c) private times for separate bearers;
(d) literal temporal dilation;
(e) temporal curvature;
(f) or the absence of one common cosmic ordering.

The observations concern physical systems, interactions, records, and modelled relations.

17.6 The non-reconciliatory empirical-accounting burden

Rejecting relativistic temporal ontology does not remove the obligation to account quantitatively for accepted observations.

For a phenomenon class D, a claimed ITOF physical account must identify:

(1) the physical bearers;
(2) the bearer-specific variables;
(3) the physical interactions and mechanisms;
(4) the source–record chain;
(5) the protocol and accepted records;
(6) the auxiliary quantitative model;
(7) the uncertainty specification;
(8) the prospective prediction;
(9) the discrepancy criterion;
(10) and the preregistered acceptance tolerance.

Let

$$\widehat{O}^{\mathrm{ITOF}}_{D;P,M}$$

be the prospectively declared predicted output, and let

$$O^{\mathrm{obs}}_{D;P}$$

be the accepted observed output in a common comparison codomain $\mathfrak{O}_{D;P}$. No vector-space, subtraction, or norm assumptions are imposed. Instead declare a protocol- and model-relative scalar discrepancy functional

$$\Delta_{D;P,M} : \mathfrak{O}_{D;P} \times \mathfrak{O}_{D;P} \longrightarrow \mathbb{R}_{\geq 0}. \tag{551}$$

The functional is not assumed to be a metric: symmetry, the triangle inequality, and identity of indiscernibles are not required unless the declared protocol and model impose them. Let $\varepsilon^{\mathrm{acc}}_{D;P,M} \in \mathbb{R}_{\geq 0}$ be the prospectively declared acceptance tolerance.

Define restricted physical-accounting adequacy by

$$\begin{aligned} &\mathrm{RestrictedPhysicalAccountingAdequacy}_{D;P,M} \\ &\quad \Longleftrightarrow \mathrm{ProspectivelyDeclaredITOFAccount}_{D;P,M} \\ &\qquad \wedge \mathrm{ValidatedRecordChain}_{D;P,M} \\ &\qquad \wedge \Delta_{D;P,M}\left(\widehat{O}^{\mathrm{ITOF}}_{D;P,M}, O^{\mathrm{obs}}_{D;P}\right) \leq \varepsilon^{\mathrm{acc}}_{D;P,M}. \end{aligned} \tag{552}$$

This adequacy is restricted to the declared physical account and output class.

It does not establish agreement with relativistic temporal ontology.

Ontological rejection is not an alternative calculation

Where no bearer-specific mechanism, quantitative model, and prospective prediction have been supplied, ITOF has stated an ontological rejection and a research burden.

It has not yet supplied a complete alternative calculation for that phenomenon.

Therefore,

$$\mathrm{RelativisticTemporalOntologyRejected} \not\Rightarrow \mathrm{CompleteAlternativeCalculationSupplied}\,. \tag{553}$$

This limitation must be stated rather than concealed.

It does not convert the rejection into compatibility with relativistic time.

Categorical rejection of temporal deformation

The ITOF definition assigns no metric, curvature tensor, connection, path integral, geometrical dimension, stretching operation, or rate predicate to time.

Therefore, literal attribution of the following to T_{ITOF} is type-inadmissible:

(i) curvature;
(ii) dilation;
(iii) contraction;
(iv) warping;
(v) stretching;
(vi) slowing;
(vii) acceleration;
(viii) fragmentation;
(ix) or dimensional multiplication.

The governing judgment is

$$\boxed{\text{IllTyped}\left(\text{Curved}, \text{Dilated}, \text{Contracted}, \text{Warped}, \text{Slowed}, \text{Accelerated}; T_{\text{ITOF}}\right).} \tag{554}$$

These predicates must be assigned to objects for which they are well-typed.

Correct physical attribution

Curvature may be assigned to a metric and connection.

A worldline functional may have a value determined by a path and metric.

A physical clock may produce one numerical output rather than another.

A signal may undergo path-dependent propagation.

A material system may accumulate different physical effects.

None of these facts transfers the corresponding predicate to time.

Thus,

$$\begin{gathered} \text{CurvatureDefinedFor}(g, \nabla, R) \not\Rightarrow \text{CurvatureAttributableTo}(T_{\text{ITOF}}), \\ N_{C_1,P}(r_1) \neq N_{C_2,P}(r_2) \not\Rightarrow \text{UnequalTimes}(C_1, C_2). \end{gathered} \tag{555}$$

17.7 Lorentz transformations

For standard inertial coordinates in one spatial dimension, a special-relativistic transformation may be written

$$t' = \gamma_v \left(t - \frac{vx}{c^2}\right), \qquad x' = \gamma_v(x - vt), \qquad \gamma_v = \frac{1}{\sqrt{1 - v^2/c^2}}. \tag{556}$$

These equations transform coordinate components within the declared relativistic model.

The symbols t and t' are coordinate values.

They are not T_{ITOF}.

If

$$\Lambda : x^\mu_F(e) \longmapsto x^\mu_{F'}(e), \tag{557}$$

then

$$\boxed{T_{\text{ITOF}} \notin \text{Dom}(\Lambda).} \tag{558}$$

A coordinate transformation changes the assigned coordinate representation.

It does not transform the universal cosmic ordering.

17.8 Coordinate simultaneity

Coordinate simultaneity in frame F may be represented by

$$e_1 \sim_F e_2 \Longleftrightarrow t_F(e_1) = t_F(e_2). \tag{559}$$

Its frame dependence is a property of the coordinate assignment.

Common-stage participation is instead governed by bearer membership in one actual common stage:

$$\mathrm{CoStageBearer}(A, B; s) \iff A \in \mathcal{S}_{\mathrm{phys}}(s) \wedge B \in \mathcal{S}_{\mathrm{phys}}(s). \tag{560}$$

Coordinate equality does not create common-stage presence.

Coordinate inequality does not divide the common cosmic stage.

17.9 Synchronization does not establish exact co-realization

A synchronization procedure compares signals, clock records, conventions, and model assumptions.

Let

$$\mathrm{Sync}_{F,P}(r_1, r_2) \tag{561}$$

denote a synchronization result under frame F and protocol P. Let $\mathrm{RecordOf}_{P,M}(r_i, e_i)$ denote the accepted attribution of record r_i to occurrence e_i.

Then

$$\mathrm{RecordOf}_{P,M}(r_1, e_1) \wedge \mathrm{RecordOf}_{P,M}(r_2, e_2) \wedge \mathrm{Sync}_{F,P}(r_1, r_2) \not\Rightarrow \mathrm{CoRealized}(e_1, e_2). \tag{562}$$

Exact co-realization requires an independently warranted equality of the actual stage mappings of the two occurrences.

17.10 The Minkowski interval

The Minkowski interval in a declared coordinate representation may be written

$$ds^2 = -c^2 dt^2 + dx^2 + dy^2 + dz^2. \tag{563}$$

Its Lorentz invariance is an invariance property of the metric model.

It does not identify the interval with ITOF time:

$$\mathrm{InvariantUnder}\Big(ds^2, \Lambda_{\mathrm{Lorentz}}\Big) \not\Rightarrow ds^2 \equiv T_{\mathrm{ITOF}}. \tag{564}$$

The metric interval possesses numerical and geometrical operations that the non-metric cosmic ordering does not possess.

17.11 ITOF does not derive Lorentz transformations

The foundational commitments

$$\mathcal{S}_C, \qquad \prec_C, \qquad \mathrm{CMA}, \qquad \mathrm{UCC}$$

do not derive the Lorentz transformations.

Therefore,

$$(T_{\mathrm{ITOF}}, \mathrm{CMA}, \mathrm{UCC}) \not\Rightarrow \Lambda_{\mathrm{Lorentz}}. \tag{565}$$

Explaining the calculational success of Lorentz relations through bearer-specific physical mechanisms remains a separate research task.

17.12 Proper time as a metric functional

For a timelike worldline γ in a Lorentzian metric $g_{\mu\nu}$, proper time is defined within relativity by

$$\tau[\gamma, g] = \frac{1}{c} \int_{\gamma} \sqrt{-g_{\mu\nu}\, dx^{\mu} dx^{\nu}}. \tag{566}$$

This is a metric functional of a declared path and metric.

Its type is not the type of ITOF time:

$$\boxed{\tau[\gamma, g] \not\equiv T_{\mathrm{ITOF}}.} \tag{567}$$

If

$$\tau[\gamma_1, g] \neq \tau[\gamma_2, g], \tag{568}$$

the inequality belongs to the two model-defined functionals.

It does not establish two times or two cosmic extensions.

17.13 Worldlines and physical histories

A relativistic worldline is a modelled geometrical object.

A physical history is the bearer-specific ontic object

$$\mathcal{H}_A = \left(I_A, \prec_C|_{I_A}, X_A\right). \tag{569}$$

The two have different types:

$$\mathrm{Type}(\gamma_A) = \mathsf{GeometricWorldline}, \qquad \mathrm{Type}(\mathcal{H}_A) = \mathsf{PhysicalBearerHistory}. \tag{570}$$

A worldline may represent selected spatial and coordinate features of a bearer history under a model.

It does not become the complete physical history.

17.14 Twin-type comparisons

Two physical bearers may reunite with different:

(i) clock records;

(ii) physiological states;
(iii) molecular configurations;
(iv) accumulated damage;
(v) energy exchanges;
(vi) or other bearer-specific outcomes.

The directly warranted ontic conclusion is that the histories differ:

$$\mathcal{H}_A \neq \mathcal{H}_B. \tag{571}$$

It does not follow that the bearers occupied distinct times:

$$\mathcal{H}_A \neq \mathcal{H}_B \not\Rightarrow \text{DistinctCosmicExtensions}(A, B). \tag{572}$$

Both histories remain restricted to the same universal ordering $\prec_C$.

17.15 Ideal relativistic clocks

An idealized relativistic clock relation may be written

$$n_{C,P}^{\text{ideal}} = \alpha_P \tau[\gamma, g] + \beta_P. \tag{573}$$

This equation relates a modelled clock output to a metric functional.

It does not identify either object with time:

$$n_{C,P}^{\text{ideal}} \not\equiv \tau[\gamma, g] \not\equiv T_{\text{ITOF}}. \tag{574}$$

The first nonidentity may be replaced by a declared representational or calibration relation where the model so specifies.

The second nonidentity remains categorical.

17.16 Real clocks as physical systems

A real clock has a bearer-specific physical process, condition set, device model, and protocol.

Its predicted output may be represented by

$$n_{C,P}^{\text{pred}} = \mathcal{K}_{C,P} \left(\Xi_{C,P}, \theta_{C,P}, \mathcal{M}_C, P \right), \tag{575}$$

where the inputs represent the declared physical clock history, conditions, mechanism, and protocol.

A relativistic functional may be included as one model input.

Agreement with the output establishes only the declared clock-model calculation.

17.17 Clocks do not measure time ontologically

The clock reading satisfies

$$N_{C,P}(r_C) \not\equiv T_{\mathrm{ITOF}}. \tag{576}$$

The precise statement is:

A physical clock undergoes bearer-specific physical processes and produces standardized records under a declared protocol.

ITOF rejects the ontological statement that the clock measures a quantity, rate, deformation, or portion of time.

17.18 Differential clock readings

For two clocks,

$$\Delta N_{C_1C_2}^{(P)} = \Gamma_{1,P}(n_{C_1}) - \Gamma_{2,P}(n_{C_2}) \tag{577}$$

is a protocol-defined numerical comparison.

If

$$\Delta N_{C_1C_2}^{(P)} \neq 0, \tag{578}$$

the directly warranted conclusion is that the physical clock histories produced different standardized outcomes under their respective conditions.

It does not entail:

$$\Delta N_{C_1C_2}^{(P)} \neq 0 \not\Rightarrow \mathrm{TimeDilated}\,. \tag{579}$$

17.19 Frequency and redshift comparisons

A frequency or redshift relation may be represented by

$$1 + z = \frac{\nu_{\mathrm{emit}}}{\nu_{\mathrm{receive}}}. \tag{580}$$

The quantities concern a physical emitter–signal–receiver chain and its modelled ratio.

The redshift is not time:

$$z \not\equiv T_{\mathrm{ITOF}}. \tag{581}$$

The physical interpretation must identify the source, propagation, receiver, detector, record, and model contributions.

17.20 Metric geometry and curvature

A relativistic spacetime model introduces a manifold, metric, connection, curvature, fields, and event relations.

The line element

$$ds^2 = g_{\mu\nu} dx^\mu dx^\nu \tag{582}$$

does not define time in ITOF.

Curvature is assigned to the geometrical objects:

$$\text{Curved}\,(g, \nabla, R)\,. \tag{583}$$

Its application to ITOF time is type-inadmissible:

$$\text{IllTyped}\,(\text{Curved}; T_{\text{ITOF}})\,. \tag{584}$$

17.21 Einstein's field equation

The Einstein field equation is

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}. \tag{585}$$

It relates geometrical tensors to a stress–energy tensor within general relativity.

ITOF does not accept this equation as:

(i) a definition of time;
(ii) proof that time is curved;
(iii) proof that the universe is identical with a spacetime geometry;
(iv) or a replacement for the common cosmic ordering.

Mathematical covariance and empirical calculation do not supply temporal identity.

17.22 Geometrical hypersurfaces are not cosmic stages

Let Σ_λ be a geometrical hypersurface or foliation leaf in a declared model.

Then

$$\text{Type}(\Sigma_\lambda) = \mathsf{GeometricHypersurface}, \qquad \text{Type}(s) = \mathsf{CommonCosmicStage}. \tag{586}$$

Therefore,

$$\boxed{\Sigma_\lambda \not\equiv s.} \tag{587}$$

No constant-coordinate surface defines the common cosmic stage merely by being mathematically global.

Additional geometrical dimensions

A mathematical theory may introduce additional manifold or coordinate dimensions, as in historically influential higher-dimensional relativistic proposals [9, 10].

Their introduction does not establish that time itself is a dimension or that several times physically exist.

Thus,

$$\text{AdditionalModelDimension} \not\Rightarrow \text{AdditionalTime}\,. \tag{588}$$

ITOF time is not a compactifiable, warpable, or multiplicable geometrical dimension.

Relativistic causality and cosmic ordering

The cosmic relation

$$\prec_C$$

orders common cosmic stages.

A relativistic causal relation orders or classifies model events under a metric, light-cone, and signal structure.

The relations possess different domains.

Therefore,

$$\text{RelCausal}(e_1, e_2) \not\equiv \sigma(e_1) \prec_C \sigma(e_2). \tag{589}$$

A physical causal claim requires warrant from actual bearers, interactions, mechanisms, and records.

CMA does not supply an instantaneous signal channel.

Propagation delay

Propagation delay affects physical access and influence.

It does not postpone the source bearer's realization at its own common stage.

For a source event and later detector record, the source–record order is fixed by Equation (430).

Any coordinate or operational interval used to represent the relation remains a model or record quantity:

$$\Delta t^{(P)} \not\equiv T_{\text{ITOF}}. \tag{590}$$

Distance does not divide the universal cosmic stage.

17.23 General covariance

General covariance is a formal property of equations and their representations.

It does not establish a temporal ontology:

$$\text{Covariant}(\mathcal{E}) \not\Rightarrow \text{TemporalOntology}(\mathcal{E}). \tag{591}$$

The fact that equations retain a form under transformations does not identify the transformed coordinate quantities with time.

ITOF invariance

ITOF invariance concerns the fixed and irreversible ordering

$$\prec_C .$$

It is not:

(i) a Lorentz scalar;
(ii) a tensor transformation law;
(iii) a coordinate symmetry;
(iv) a gauge freedom;
(v) or a geometrical invariance claim.

The invariant content is that later stages remain later and that the one cosmic ordering is not inverted by bearer motion, coordinate change, record convention, or model transformation.

The physical accounting of relativistically modelled results

A complete ITOF application to a phenomenon commonly modelled by relativity must not stop at the statements

$$q \not\equiv T_{\mathrm{ITOF}}$$

or

$$\text{TimeDilation is ill-typed.}$$

It must additionally explain or model the actual physical differences in the bearers and records.

The required account must specify:

(1) what changed in each physical system;
(2) which interactions produced the change;
(3) how the relevant record was formed;
(4) how the numerical comparison was constructed;
(5) which physical conditions determine the difference;
(6) and which prospective observations distinguish the proposed account from alternatives.

Without this work, the section supplies a foundational rejection, not a complete physical replacement theory.

17.24 No transfer from success to ontology

The following inference is invalid:

$$\mathrm{AccurateRelativisticPrediction}(q) \Longrightarrow q \equiv T_{\mathrm{ITOF}}. \tag{592}$$

Predictive success establishes a relation among:

(i) a model;
(ii) a physical bearer or bearer family;
(iii) a protocol;
(iv) accepted records;
(v) a comparison rule;
(vi) and an accuracy criterion.

It does not by itself establish the physical identity of the model's quantities.

No transfer from terminology to ontology

The use of words such as:

(a) coordinate time;
(b) proper time;
(c) elapsed time;
(d) time dilation;
(e) spacetime;
(f) or temporal dimension

does not grant the named quantity the type of T_{ITOF}.

Terminology does not override definition and type.

No transfer from instruments to time

A clock, detector, oscillator, atomic transition, decay process, or astronomical cycle is a physical bearer or process.

Its output may be precise, reproducible, standardized, and practically indispensable.

Those properties do not make the output time.

Thus,

$$\begin{aligned} \mathrm{Precise}(N_{C,P}) &\not\Rightarrow N_{C,P} \equiv T_{\mathrm{ITOF}}, \\ \mathrm{Standardized}(N_{C,P}) &\not\Rightarrow N_{C,P} \equiv T_{\mathrm{ITOF}}. \end{aligned} \tag{593}$$

No private temporal histories

Unequal physical histories do not create private times.

For all physical bearers A,

Every bearer identity domain remains within the one common cosmic domain by Equation (154).

Bearer-specific histories differ in their:

(i) identity domains;
(ii) physical states;
(iii) interactions;
(iv) spatial trajectories;
(v) clock outputs;

(vi) and accumulated outcomes.

Their order is nevertheless inherited from the same $\prec_C$.

No relativistic redefinition of the common stage

The common cosmic stage is not defined by:

(a) equal coordinate values;
(b) mutual signal exchange;
(c) Einstein synchronization;
(d) a spacelike hypersurface;
(e) equal proper-time values;
(f) or agreement among clocks.

Those procedures and objects may support operational or model-relative comparisons.

They do not generate the common cosmic stage.

17.25 Final relativistic boundary

The governing judgment is:

Golden formulation: final relativistic type boundary

$$\boxed{\begin{aligned} \text{coordinate} &\not\equiv T_{\text{ITOF}}, \\ \text{metric interval} &\not\equiv T_{\text{ITOF}}, \\ \text{proper-time functional} &\not\equiv T_{\text{ITOF}}, \\ \text{clock output} &\not\equiv T_{\text{ITOF}}, \\ \text{spacetime geometry} &\not\equiv T_{\text{ITOF}}. \end{aligned}} \tag{594}$$

V29/F9 asserts no compatibility, reconciliation, synthesis, or ontological coexistence with relativistic time.

Relativistic coordinates, metrics, worldline functionals, causal classifications, spacetime geometries, and clock predictions remain mathematical model objects or physical-system outputs.

None is identical with time, a common cosmic stage, or the universal fixed and irreversible ordering $\prec_C$.

Clocks remain indispensable physical instruments.

Their utility does not grant them temporal identity.

18. Scope, Limits, and Governing Conclusion

18.1 Governing commitments

V29/F9 adopts the following connected commitments, each retaining the formal status assigned in the relevant section:

(1) The universe denotes the totality of all actual physical systems, not an additional bearer beside them.

(2) Time denotes the universal ordering and succession of common cosmic stages in one common cosmic extension, $T_{\text{ITOF}} = (\mathcal{S}_C, \prec_C)$, where $\prec_C$ is fixed and irreversible.

(3) Time is not matter, energy, a field, a force, a coordinate, a metric interval, a proper-time functional, a clock output, a moving carrier, or a causal participant in change.

(4) At every actual common cosmic stage, CMA assigns common-stage presence and bearer-specific positive physical realization to every then-existing bearer. Stage unity does not imply equality of states, mechanisms, magnitudes, rates, locations, or records.

(5) Every bearer has one identity-bounded history $\mathcal{H}_A = (I_A, \prec_C|_{I_A}, X_A)$ within the same cosmic ordering, with one unique formation member and one unique ending member. Formation does not require an earlier state of the same bearer, and one-stage histories are admissible.

(6) UCC is the bearer-relative consequence of CMA over later members of a continuing identity history. Stability, equilibrium, rest, and recurrence are criterion-relative and do not entail complete physical stasis or reversal of $\prec_C$.

(7) Functional failure is distinct from identity ending. Every attained non-terminal ending has a physically continuous outcome, but only an identity-producing ending forms one or more successor identities. Other outcomes may contribute to already existing bearers.

(8) Place denotes a spatial position, extent, region, or relation; it is not an independent bearer merely because it is named or occupied. Motion is change in bearer position or spatial relations, not movement through time.

(9) Local day, night, dates, time zones, and clock readings classify local physical conditions and standardized records. They do not divide the common cosmic ordering into private times.

(10) A clock is a changing physical bearer that produces records and numerical readings under a protocol. Neither the record nor the reading is time or a count of common cosmic stages.

(11) Observation proceeds through occurrence, access interaction, record realization, reading, and warranted inference. These objects retain different types. Nondetection does not by itself establish absence of physical realization.

(12) First detection, threshold crossing, first record of existence, and first record of ending do not automatically identify the exact ontic stage of realization, formation, noticeability, or ending.

(13) Remote-source realization, emission, propagation, arrival, detector interaction, and record formation are distinct physical occurrences. A signal does not transport time or carry an earlier cosmic stage into the detector.

(14) Historical explanation and prediction use protocol- and model-conditioned reconstructions rather than complete possession of the ontic history. Prediction neither actualizes a future occurrence nor modifies the cosmic ordering.

(15) Finite studies test restricted hypotheses and consequences. A positive witness is not a stagewise exhaustive test; operational stasis is not complete physical stasis; a restricted adverse result, an ontological counterinstance, and a scientific rejection decision remain distinct.

(16) V29/F9 rejects relativistic temporal ontology. Coordinates, metric intervals, proper-time functionals, spacetime geometries, worldlines, causal classifications, and clock outputs are not time as defined by ITOF. Calculational success does not transfer temporal identity.

Epistemic, formal, and application limits

V29/F9 assigns no metric magnitude, equal spacing, canonical coordinate, or exact cardinality to the complete cosmic-stage domain. It does not claim that every bearer realization is directly observable, every record determines one exact stage, every boundary can be localized exactly, every successor set can be reconstructed completely, or a finite programme can exhaust universal quantifiers.

Formal notation distinguishes types, dependencies, domains, and valid or invalid entailments. It does not create a physical bearer, mechanism, stage, identity, transformation, record, or warrant. Every application must independently specify its bearer criterion, numerical-identity criterion, state or occurrence representation, realization routes, record chain, uncertainty model, and adverse conditions. The ontic–epistemic distinction may not be used to neutralize every adverse result; a newly proposed unobserved route requires a physical basis, expected record consequences, and prospective testing.

Relativistic and quantitative boundary

The rejection of relativistic temporal ontology is categorical and non-reconciliatory. ITOF does not reinterpret common stages as a relativistic foliation, identify clock output with proper time, or treat metric intervals as quantities of ITOF time. At the same time, ontological criticism does not substitute for a quantitative account. Any ITOF application addressing accepted observations must identify the relevant bearers, interactions, record chain, model, uncertainty, prospective prediction, discrepancy criterion, and acceptance tolerance.

18.2 Long-term use and final statement

Future applications and empirical studies should treat V29/F9 as the governing reference unless a later foundational reconstruction expressly supersedes it. New domains, quantitative models, restricted tests, and difficult-system analyses can proceed without creating a new foundational version.

Golden governing conclusion.

At every actual common cosmic stage, the stage is one and the bearer-specific physical realizations are many. Every bearer forms, persists where its identity continues, transforms, and ends within the same fixed and irreversible ordering. Records provide bounded access to selected manifestations of those histories; they do not become the stages or occurrences they represent. No bearer moves through time, no clock measures time as an ontological quantity, no signal transports an earlier stage, and no coordinate or metric object acquires the identity of time. Time denotes the universal ordering and succession of common cosmic stages in one common cosmic extension. Physical systems change; the universal ordering does not.

A. Canonical Register, Dependency Map, and Application Audit

A.1 Purpose and formal-status register

This appendix is a compact consistency reference. It introduces no new axiom or mechanism and does not repeat the full arguments of the main text.

Item	Status	Governing role
Universe	Ontological commitment	Totality of actual physical systems; not an additional bearer.
$T_{\mathrm{ITOF}} = (\mathcal{S}_C, \prec_C)$	Canonical definition	Time as universal common-stage ordering and succession.
Actual first stage	Physical-origin postulate	Unique least actual cosmic stage; not derived from the time definition.
CMA	Universal axiom	Common-stage presence and bearer-specific positive realization at every actual stage.
I_A and $\mathcal{H}_A$	Bearer definitions	Identity domain and bearer history within the common ordering.
Identity-Domain Convexity	Persistence principle	Governs identity between warranted bounds; does not create boundaries.
Formation and ending	Boundary commitments	Unique bearer-history limits; both are positive realization subtypes.
NCEC	Independent cosmic-domain condition	Requires at least one actual stage later than cosmic origin; does not imply density, discreteness, or a greatest stage.
Same-stage cascade exclusion	Model-coherence constraint	Excludes infinite one-stage successor sequences and, with unique boundaries, yields successor acyclicity.
Greatest–terminal equivalence	Derived proposition	Conditional on ending, outcome closure, stage-indexed successorship, cascade exclusion, strict total order, and the sequence convention; it does not assert existence of a greatest stage.
UCC	Derived proposition	Follows bearer-relatively from CMA over later history members.
Stability and recurrence	Criterion-relative classifications	Do not entail complete stasis or stage recurrence.
Spatial realization and motion	Bearer relations	Position and spatial change; not movement through time.
Clocks and records	Physical and operational objects	Produce readings and evidence; are not time or stages.
Candidate stages and reconstructed histories	Epistemic objects	Model-conditioned constraints; not complete ontic histories.
Physical outcome and successors	Ending architecture	Outcome is broader than new-identity production; successorship requires separate warrant.
Restricted empirical witness	Evidential conclusion	Supports a bounded bearer claim; does not exhaust stages or universal quantifiers.

Item	Status	Governing role
Relativistic quantities	External model objects	Coordinates, metrics, proper-time functionals, and geometries are not ITOF time.
Quantitative ITOF account	Research requirement	Requires an independent bearer-specific model and prospective empirical comparison.

A.2 Dependency spine and non-circularity

Define $X \lhd_{\text{dep}} Y$ to mean that the admissible formulation or derivation of Y depends upon X, without implying that X alone entails Y. The governing order is

$$\boxed{\begin{aligned}\text{primitive cosmic and bearer types} &\lhd_{\text{dep}} \text{time and cosmic commitments}\\ &\lhd_{\text{dep}} \text{identity and boundaries}\\ &\lhd_{\text{dep}} \text{derived change and outcome results}\\ &\lhd_{\text{dep}} \text{evidential applications and confrontation.}\end{aligned}} \tag{595}$$

The following arrows must not be reversed: CMA is not inferred from UCC; formation and ending are not derived from successorship; outcome closure does not assume that every ending creates a successor; the cascade constraint is not derived from temporal order; successor acyclicity and greatest–terminal equivalence depend on their explicitly listed boundary, closure, successor, order, and metatheoretic premises; exact-stage warrant is not derived from the precision of the record under examination; empirical convergence does not redefine the realization predicate; and rejection of relativistic temporal ontology does not establish that an alternative calculation has already been completed.

A dependency cycle is inadmissible:

$$\neg\exists n \geq 1\ \exists X_0, \ldots, X_n\, [X_0 = X_n \wedge \forall i < n\ X_i \lhd_{\text{dep}} X_{i+1}]\,. \tag{596}$$

A.3 Identity, observation, and application audit

Before accepting a bearer-level claim, verify that the bearer and numerical-identity criterion are explicit; formation is distinguished from first detection; persistence is not inferred from name, material, location, function, appearance, or selected state alone; functional failure is not equated with ending; physical outcome is distinguished from successor formation; every successor has a new-identity and production warrant; and an already existing recipient is not misclassified as a newly formed successor.

Before accepting an observational claim, verify that source occurrence, access interaction, detector, record bearer, reading, and inference are distinguished; provenance and attribution are stated; record order is not transferred to cosmic-stage order without a bridge; nondetection is restricted to declared sensitivity and coverage; first detection or threshold crossing is not treated as an exact ontic boundary; and a reconstructed history is not identified with the complete bearer history.

For clocks and remote records, verify that the physical clock process, record map, reading map, pairing rule, calibration, uncertainty, source, propagation path, detector contribution, and comparison model are explicit. A reading is not time, common cancellation is not zero propagation, and a received record is not the source's present complete state.

Every domain application must state its bearer class, identity rule, represented variables, realization routes, record chain, protocol, model, coverage, uncertainty, positive-witness conditions, adverse conditions, and revision rule. Difficult stationary, isolated, equilibrium, periodic, ground-state, vacuum, or fixed-point candidates remain unresolved unless either a positive physical route or bearer-complete stasis is adequately warranted. No unspecified hidden mechanism may be introduced solely after an adverse result.

Audit outcomes are *admissible*, *restricted*, *unresolved*, or *inadmissible*. Passing the audit establishes consistency with V29/F9; it does not by itself prove the physical truth of the claim.

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