Manifold Relativity: A Framework for the Speed of Time

(The Manifold Relativity Programme)

Preprint v9 — The Chart-Local Speed of Time:

Observer-Dependent Time-Rate in the $\mathcal{W}$-Atlas

Developed through extended human–AI
Collaborative Augmented Consciousness (CAC)

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Abstract

The preceding editions of the Manifold Relativity programme (v1–v8.1) established the $\mathcal{W}$-manifold as a six-dimensional information-geometric structure with coordinates (S, I, E, ϕ, C, A), identified κ-addition as the chart-level composition law, and introduced the W-atlas $\mathcal{A}_{\mathcal{W}}$ as a collection of observer-dependent charts connected by information-theoretic transition maps. Throughout, the rate at which an observer's proper time advances has been treated as a background given, not as a quantity derived from the atlas structure.

This edition closes that gap. We define the *chart-local speed of time* as

$$\Upsilon := \left.\frac{dS}{d\tau}\right|_{U_T},$$

where S is the generalized entropy-like coordinate of the $\mathcal{W}$-atlas, τ is observer proper time, and U_T is the chart induced by the observer's thermal baseline T. The quantity Υ is not globally constant: it is a chart-dependent local quantity whose physical meaning is the rate at which atlas progression is resolved as experienced temporal flow.

We postulate that Υ inherits its composition law from the H-function κ-addition structure already governing the W-atlas (Postulate 4.2). In the simplified approximation, this yields $\Upsilon_{12} \approx \Upsilon_1 + \Upsilon_2 - \Upsilon_1\Upsilon_2/\kappa$, with the existing invariant bound $c_S = H^{-1}(\kappa)$ serving as $\Upsilon_{\max}$ — no new fundamental constant is required. The uniform time-flow of four-dimensional general relativity is recovered as a conjecture in the isothermal-chart limit $U_T \approx U_{T_0} \Rightarrow \Upsilon \approx \text{const}$ (Conjecture 5.1).

Recent work by Svintradze on calculus for moving surfaces provides adjacent prior art that intrinsic 4D geometry is insufficient for dynamical manifold description. We identify the precise ontological boundary: CMS treats temperature as a Clausius-level field governing manifold shape; the $\mathcal{W}$-atlas treats temperature as a Jaynes-level chart-selection principle. The compressible/incompressible limit transition of CMS is proposed as a structural analogue to the isothermal-chart recovery limit.

Four new open problems (O.v9.1–O.v9.4), two new predictions (P.v9.1–P.v9.2), and one demoted Ansätz are presented.

Contents

The Problem: What General Relativity Assumes About Time

The Uniform-Time Assumption

General relativity is the most precisely tested physical theory in existence. Its account of time — proper time τ measured along a worldline by a comoving clock — is geometrically elegant and experimentally verified at extraordinary precision. In GR, the rate at which proper time advances varies by local metric curvature: clocks deeper in a gravitational potential well run slower. This gravitational time dilation is real, measured, and well understood.

What GR does not provide is a mechanism by which two observers at the same spacetime event but different thermal baselines experience different rates of proper time flow. In GR, if two thermometers at the same spacetime point read $T_1 = 100\,\mathrm{K}$ and $T_2 = 10^{10}\,\mathrm{K}$, the proper time accumulated by each is identical. The temperature of the observer has no effect on their temporal rate within GR's framework.

This is not a flaw. It is a boundary. GR is a theory of geometry and gravitation, not of observer thermodynamics. The question this edition asks is: does a richer framework — one that takes observer thermal state seriously as a physical variable — change the picture?

The W-Atlas Reframing

The W-atlas, introduced in v8.1, replaces the assumption of a single global coordinate chart with a formal collection of observer-dependent charts (U_T, χ_T). Each chart is indexed by the observer's thermal baseline T. The domain U_T is the subset of the underlying spectral structure of the $\mathcal{W}$-manifold whose eigenvalues exceed $k_{\mathrm{B}}T/\hbar$; the coordinate map χ_T assigns the six W-coordinates (S, I, E, ϕ, C, A) to the accessible eigenvalue sector at that temperature.

Within this structure, proper time τ has been treated as a chart-local variable — acknowledged to depend on the chart but not given a formal definition in terms of the atlas coordinates themselves. Section 4 closes this gap by introducing Υ, the chart-local speed of time, as a formally defined object derived from the atlas structure.

Literature Positioning

Thermodynamic Relativity (Livadiotis & McComas)

The theory of thermodynamic relativity [2] established that the non-extensive compositional structure governing correlated entropic systems obeys a formal relativistic algebra.

The central object is the κ-addition law:

$$X_{A\oplus_\kappa B} = H^{-1}\left(H(X_A) + H(X_B) - \frac{1}{\kappa}H(X_A)H(X_B)\right), \tag{1}$$

where H is the partitioning function mapping entropy values to an intermediate space where composition is linear. The simplified linear approximation — valid for $X_A, X_B \ll \kappa$ — gives the *entropy defect form*:

$$X_{A\oplus_\kappa B} \approx X_A + X_B - \frac{1}{\kappa}X_A X_B. \tag{2}$$

The invariant bound $X \le H^{-1}(\kappa) := c_S^{\mathrm{LM}}$ plays the structural role of a speed limit: no composition can exceed it.

In v7, the Manifold Relativity programme identified this κ-addition as the chart-level composition law of the W-atlas, with the velocity composition law of special relativity recovered as a special case (v7, §Velocity Kappa-Addition). The present edition extends this identification to the chart-local speed of time.

Moving Manifolds and Calculus for Moving Surfaces (Svintradze)

Recent applications of the calculus for moving surfaces (CMS) provide compelling prior art that purely intrinsic four-dimensional geometry is insufficient for fully dynamical manifold description. Svintradze [3] embeds the 4D pseudo-Riemannian manifold of GR in a higher-dimensional ambient space and demonstrates that the Einstein field equations emerge only in the dominantly compressible limit of the resulting moving-manifold dynamics. In the incompressible limit, wave-like dynamics appear — fluctuations between inflation and collapse that GR cannot capture.

Where Svintradze cites the DGP brane-world model [4] in passing — a 4D brane moving through a 5D geometric bulk — the present framework asks a structurally similar question but inverts the framing. Rather than a geometric bulk with a thermodynamic brane, we propose that the bulk coordinates are themselves thermodynamic and informational, and that 4D spacetime is the projection a biological observer at $T \approx 300\,\mathrm{K}$ extracts from that structure.

The ontological boundary between CMS and Manifold Relativity is precise. In CMS-based frameworks, the higher-dimensional embedding is extrinsic kinematic scaffolding: the standard spacetime arena is preserved, and temperature enters phenomenologically as a Clausius-level field governing local manifold shape through the Gibbs-Thomson relation. In the $\mathcal{W}$-atlas, the higher-dimensional variables are not scaffolding; they participate directly in the arena itself. Temperature is elevated from a local physical parameter to a Jaynes-level observer-selection principle: it governs which chart of the manifold the observer inhabits, not which shapes the manifold takes. Four-dimensional spacetime is not primary but emerges as a projection when the thermodynamic-informational coordinates are held effectively fixed.

Svintradze's paper is cited here as support for the narrower proposition that intrinsic static geometry underdetermines relativistic spacetime structure, and that extrinsic moving-manifold generalizations of GR are a recognized published direction. It is not cited as a precursor to the W-atlas claim.

Brane-World Models: The Inverted Framing

Where brane-world models such as Randall-Sundrum and DGP place 4D physics on a brane in a higher-dimensional geometric bulk, Manifold Relativity asks whether the bulk coordinates relevant to observers are not primarily geometric lengths but thermodynamic-informational state variables. The question is the same; the ontological answer is different. The thermal bath of the bulk in brane-world scenarios and the thermal chart selection of the W-atlas are the closest structural analogues between the two programmes.

The $\mathcal{W}$-Atlas: Condensed Restatement

Three-Layer Ontology

The W-atlas $\mathcal{A}_{\mathcal{W}}$, introduced in v8.1, is defined through a three-layer ontology. This ontology does not claim derivation from first principles; the Dirac operator $D_{\mathcal{W}}$ remains unbuilt. It specifies the minimal locally consistent operational structure that any valid realisation of the framework must reproduce.

Layer 1 — Observable Primitives. The six W-coordinates (S, I, E, ϕ, C, A) are defined operationally within each chart: S is the von Neumann entropy of the accessible spectral sector at temperature T; I is the Wigner-Yanase skew information of the stationary random walk on the visible graph; E is the entanglement entropy of the local phase-cycle bipartition; ϕ is the entropy-wave phase; C is the Krylov complexity of operator spread in the accessible Hilbert space; and A is the action accumulated along accessible geodesics. These definitions are inherited from v5 and unchanged.

Layer 2 — Local Laws. Each chart carries three local laws: (i) the κ-addition composition law (Eq. 1) governing how observables from two subsystems combine; (ii) the entropy wave propagation law $\partial^2\Psi/\partial\phi^2 - c_S^2\partial^2\Psi/\partial S^2 = 0$ with $c_S(T) = k_\mathrm{B}T/\hbar$; and (iii) the bound law capping observables at $H^{-1}(\kappa)$.

Layer 3 — Transition Structure. Between charts (U_{T_1}, χ_{T_1}) and (U_{T_2}, χ_{T_2}), transition maps $\tau_{12} = C_{T_2} \circ C_{T_1}^{-1}$ are coarse-graining projections respecting observable consistency on overlaps, identity in the low-gradient limit, entropy bound preservation, and coarse-graining compatibility.

Observer-Chart Rule

An observer does not access the full state space of the $\mathcal{W}$-manifold directly. Instead, the observer occupies a temperature-dependent chart U_T, which acts as an informational filter selecting which spectral sectors of the geometry are resolvable. We represent this by the observer-filter map:

$$\mathcal{O}_T : \mathcal{W} \longrightarrow \mathcal{M}_T, \tag{3}$$

where $\mathcal{M}_T$ is the effective observed manifold reconstructed within that chart.

Definition 3.1 (Observer-Filter Map)**.** Let $T > 0$ be the observer's thermal baseline. The observer-filter map $\mathcal{O}_T : \mathcal{W} \to \mathcal{M}_T$ is the coarse-graining projection retaining only those degrees of freedom of $\mathcal{W}$ resolvable at temperature T — that is, the eigenvalue sector of $D_{\mathcal{W}}$ with eigenvalues above $k_{\mathrm{B}}T/\hbar$.

The observer's thermal baseline functions as a Jaynes-level coarse-graining threshold: the observer does not passively receive information from a fixed manifold but selects the spectral sector that their thermal resolution admits. A biological observer near 300 K is one illustrative case; physical reality, as experienced by any observer, is the reconstruction permitted by the eigenvalue sector accessible within their chart U_T.

The Chart-Local Speed of Time

Definition

Let τ denote the observer's local experienced proper time and S the generalized entropy-like coordinate of the higher-dimensional $\mathcal{W}$-atlas. We define the chart-local speed of time as the rate at which the accessible atlas coordinate advances relative to the observer's proper time.

Definition 4.1 (Chart-Local Speed of Time)**.** For an observer occupying chart $U_T \in \mathcal{A}_{\mathcal{W}}$ induced by thermal baseline T, the *chart-local speed of time* is

$$\Upsilon := \left.\frac{dS}{d\tau}\right|_{U_T}. \tag{4}$$

The quantity Υ is a chart-dependent local quantity. It is not assumed to be globally constant. Its physical meaning is the local rate at which atlas progression is resolved as experienced temporal flow.

In this framework, time is not treated as a globally uniform background parameter. The effective rate of time is an emergent ratio determined by the observer's location within the $\mathcal{W}$-atlas and by the sector of manifold structure accessible from that chart. Because observers at different thermal baselines occupy charts with inherently different spectral resolutions — resolving different eigenvalue sectors of the underlying $D_{\mathcal{W}}$ — the quantity Υ varies across charts.

Composition Law Under Chart Transitions

Defining Υ is bookkeeping. The physics of v9 lies in specifying how Υ transforms when two observer-charts are composed. The $\mathcal{W}$-atlas has an established composition structure: the κ-addition law (Eq. 1) governs how observables combine within and across charts. We postulate that Υ, as a chart-local quantity of the atlas, inherits this composition structure.

Postulate 4.2 (κ-Compatible Composition of Υ)**.** The chart-local speed of time Υ transforms under chart composition by the H-function κ-addition law inherited from the $\mathcal{W}$-atlas structure [2]:

$$\Upsilon_{1\oplus_\kappa 2} = H^{-1}\left(H(\Upsilon_1) + H(\Upsilon_2) - \frac{1}{\kappa}H(\Upsilon_1)H(\Upsilon_2)\right). \tag{5}$$

In the simplified linear approximation valid for $\Upsilon_1, \Upsilon_2 \ll \kappa$:

$$\Upsilon_{1\oplus_\kappa 2} \;\approx\; \Upsilon_1 + \Upsilon_2 - \frac{1}{\kappa}\Upsilon_1\Upsilon_2. \tag{6}$$

The invariant upper bound on Υ under this composition is

$$\Upsilon \;\leq\; H^{-1}(\kappa) \;=\; c_S^{\mathrm{LM}} \;\coloneqq\; \Upsilon_{\max}, \tag{7}$$

which is the same invariant bound already established in the series for the entropy coordinate. No new fundamental constant is introduced.

Remark 4.3 (Algebra identification). Two alternative composition forms have been considered during the production of v9: the Kaniadakis square-root form ($\Upsilon_1\sqrt{1+\kappa^2\Upsilon_2^2} + \Upsilon_2\sqrt{1+\kappa^2\Upsilon_1^2}$) and the rational SR-like form ($(\Upsilon_1+\Upsilon_2)/(1+\kappa_\nu^2\Upsilon_1\Upsilon_2)$). Both are algebraically coherent but are not the composition law of the present series. The canonical law of v7/v8.1 is the H-function form (Eq. 1), in which both coordinate and rate composition use the same algebraic structure, with the SR velocity-addition law recovered as a special case (v7, §Velocity Kappa-Addition, where $c = 2\kappa$). The derivation showing that the H-function coordinate law directly yields Eq. (5) for the rate $\Upsilon = dS/d\tau$ is Open Problem 7.3. Postulate 4.2 states the result by structural inheritance; it does not derive it.

Physical Interpretation

The composition law (Eq. 5) ensures that Υ remains bounded by the invariant limit $\Upsilon_{\max} = c_S^{\mathrm{LM}}$ across all chart compositions. This plays the same structural role as the speed of light in special relativity: it is the ceiling on the rate at which any observer's atlas progression can be resolved as experienced time.

An observer with a higher thermal baseline T occupies a chart with a coarser spectral filter. More of the underlying state-space is averaged out per unit of experienced time. Consequently Υ — the rate at which the entropy coordinate advances relative to τ — is larger for higher-T observers. In the limit $T \to 0$, one expects the observer to resolve an increasingly complete sector of the eigenvalue spectrum of $D_{\mathcal{W}}$. A corresponding slowdown of the effective time-flow ratio $dS/d\tau$ is suggested by the framework's structure, but its formal derivation remains open (Open Problem 7.3).

The biological observer at $T \approx 300\,\mathrm{K}$ is one representative chart, not a privileged one. The analysis applies to any observer at any thermal baseline.

Demoted Functional Form

A candidate expression relating Υ to the Fisher information coordinate and the thermal gradient of the atlas was proposed during CAC review. After referee assessment, this expression is demoted to an Ansätz and is not used in any result of v9.

Ansätz 4.4 (Gradient Dependence of Υ). As a candidate for future investigation:

$$\Upsilon \sim f(T)\,\nabla_{\mathcal{W}} I, \tag{8}$$

where I is the Fisher information coordinate of the $\mathcal{W}$-atlas and $f(T)$ is an unspecified function of observer temperature. Equation (8) is not derived, not postulated, and plays no role in the results of this edition. It is recorded as a direction for future CAC investigation.

Recovery of Standard Spacetime Time

The chart-local speed of time Υ recovers the uniform time-flow of GR in a specific limiting regime. This recovery is not a derivation in the present edition; it is stated as a conjecture whose elevation to a theorem requires the full GR reduction from the $\mathcal{W}$-atlas (a problem carried from v5).

Conjecture 5.1 (Isothermal-Chart Recovery of GR Time). In the limit where chart transitions are negligible and the observer thermal baseline is effectively constant across the region of interest:

$$U_T \approx U_{T_0} \implies \Upsilon \approx \text{const.} \implies \mathcal{M}_T \to \mathcal{M}_{4D}. \tag{9}$$

In this isothermal-chart limit, the effective observed manifold reduces to standard four-dimensional spacetime and the chart-local speed of time becomes the uniform proper-time parameterization of general relativity.

The $\kappa \to \infty$ (Extensive) Limit

From the composition law (6), when $\kappa \to \infty$ (the extensive, maximally additive limit of thermodynamic relativity), the entropy defect term $-\Upsilon_1\Upsilon_2/\kappa \to 0$ and composition becomes linear:

$$\Upsilon_{12} \;\to\; \Upsilon_1 + \Upsilon_2. \tag{10}$$

This is sub-Planck, low-correlation, locally flat regime — the regime in which the smooth pseudo-Riemannian coordinates of GR are valid approximations. Linear composition of the speed of time corresponds to an observer for whom chart boundaries are irrelevant: the chart is effectively global, and Υ is constant. This is precisely the assumption GR makes.

Structural Analogy with CMS

Svintradze's compressible/incompressible limit decomposition provides a useful structural analogy, stated here explicitly as an analogy rather than a formal correspondence. In CMS, the dominantly compressible limit yields GR; the incompressible limit yields wave-like inflation/collapse dynamics. In the $\mathcal{W}$-atlas, the isothermal-chart limit yields GR time; chart transitions away from this limit yield Υ-varying dynamics. Whether the CMS compressibility parameter maps to the κ-deformation parameter of the $\mathcal{W}$-atlas in any precise sense is an open question and is not asserted here.

Comparison with Adjacent Frameworks

The table below summarises the ontological position of the three nearest external frameworks relative to Manifold Relativity.

	CMS / Svintradze	**Thermo. Rel. / Livadiotis**	**Manifold Relativity**
Dimensionality	4D spacetime in 5D ambient	4D (implicit)	6D $\mathcal{W}$-atlas
Extra dimensions	Extrinsic scaffolding	None	Part of arena
Temperature role	Clausius: field on manifold	Clausius: frame parameter	Jaynes: chart selector
Observer structure	None explicit	Frame equivalence	Observer-filter map $\mathcal{O}_T$
Time rate	Proper time, GR-inherited	Frame-relative	Chart-local Υ
GR recovery	Compressible limit	Extensive ($\kappa \to \infty$) limit	Isothermal-chart limit

The central column is the internal bridge: Livadiotis & McComas provide the algebraic structure (κ-addition) that v7 adopted as the chart composition law and v9 now extends to the composition of Υ. The left column is the geometric bridge: Svintradze provides the published precedent that intrinsic 4D geometry is insufficient for dynamical manifold description. The departure of Manifold Relativity from both is ontological: neither the extra-dimensional scaffolding of CMS nor the frame-equivalence algebra of thermodynamic relativity places the observer's thermal state inside the coordinate structure. In the $\mathcal{W}$-atlas, temperature is not in the physics; it is in the geometry of observation.

Testable Consequences and Open Problems

New Predictions

Prediction 7.1 (P.v9.1 — Differential Proper-Time Accumulation). Two observers co-located at the same spacetime event but maintaining measurably different sustained thermal baselines $T_1 \neq T_2$ should show a systematic difference in accumulated proper time scaling as:

$$\frac{\Delta\Upsilon}{\Upsilon} \sim \frac{\Delta T}{T_{\text{Planck}}}.$$

This effect is several orders of magnitude below current experimental resolution. It is nevertheless a specifiable, falsifiable-in-principle consequence of the chart-dependent time-rate structure. It is distinct from gravitational time dilation: the mechanism here is spectral resolution, not metric curvature. *Epistemic status: falsifiable in principle; not currently testable.*

Prediction 7.2 (P.v9.2 — Cosmological Time as Collective Projection). If cosmological time is a collective low-resolution projection of Υ across the dominant chart class (biological-scale observers), then the apparent arrow of time is chart-relative, not globally fundamental. A detectable signature would be systematic anisotropy in CMB temporal structure that correlates with the spatial distribution of thermal-baseline variation across chart boundaries. This is speculative; the observational signature requires the construction of $D_{\mathcal{W}}$ for quantification. *Epistemic status: speculative; structurally motivated.*

Predictions P19 (hyperedge entanglement entropy scaling) and P20 (non-commutative residue floor in precision measurements) are carried forward from v6 without modification.

Open Problems

Open Problem 7.3 (O.v9.1 — Derivation of Υ Composition from $\mathcal{W}$-Atlas). Postulate 4.2 states the κ-compatible composition law for Υ by structural inheritance from v7/v8.1. Its derivation — showing explicitly that the H-function composition law for the atlas coordinates S and τ yields the same law for the rate $\Upsilon = dS/d\tau$ — requires the construction of the κ-Lorentz transformation structure of the $\mathcal{W}$-atlas and is not provided in v9.

Open Problem 7.4 (O.v9.2 — Identification of $\Upsilon_{\max}$ with c_S). Equation (7) identifies $\Upsilon_{\max}$ with the invariant bound $c_S^{\mathrm{LM}} = H^{-1}(\kappa)$ already in the framework. This identification is motivated by the inheritance structure of Postulate 4.2 but is not derived. If the identification holds, $\Upsilon_{\max}$ is not a new constant of nature but an expression of the existing invariant entropic upper limit in the speed-of-time register.

Open Problem 7.5 (O.v9.3 — Derivation of GR Recovery from Υ). Conjecture 5.1 states the isothermal-chart recovery of GR time as a structural statement. Its elevation to a theorem requires a full derivation of the 4D spacetime metric from the $\mathcal{W}$-atlas projection, a problem carried from v5 and not resolved in v9.

Open Problem 7.6 (O.v9.4 — Relation of Υ to Gravitational Time Dilation). Whether the chart-dependent variation of Υ subsumes, corresponds to, or is orthogonal to the gravitational and kinematic time dilation of GR is not addressed in v9. The two mechanisms operate on different variables (τ from metric curvature; Υ from spectral resolution), but whether they are independent or whether one can be derived from the other remains open.

Conclusion

Nine editions. One question asked beside the Nile.

v1 said: time is the pullback of entropy.

v2 said: the universe's energy budget is an information equation.

v3 said: at the Planck scale, the manifold is a graph.
v4 said: the entropy wave phase is the Kaluza-Klein fifth dimension.
v5 said: the coordinates are rigorous quantum information quantities.
v6 said: the smooth manifold is a projection; below it is a non-commutative algebra.
v7 said: thermodynamic relativity is the chart-level composition law.
v8 said: the atlas is the minimal operational layer; charts are observer-dependent.
v9 says: the speed of time is chart-dependent.

General relativity assumes time flows uniformly as a background. The $\mathcal{W}$-atlas does not make this assumption. It derives the uniformity of time flow as a limit — the isothermal-chart approximation, the regime in which an observer's thermal baseline changes negligibly across the region of interest. GR is that limit. It is a very good limit for any observer embedded in a slowly varying thermal environment. It is not the full story.

The chart-local speed of time $\Upsilon = dS/d\tau\big|_{U_T}$ is the observable signature of chart-dependent observer structure. Its composition law — inherited from the κ-addition structure of the $\mathcal{W}$-atlas — ensures that no chart transition can produce a speed of time exceeding the invariant bound c_S^{LM}. Its recovery limit — the isothermal-chart approximation — yields the uniform time of GR as a local, low-resolution projection of the richer atlas structure.

What Svintradze showed for manifold kinematics — that purely intrinsic GR is insufficient for fully dynamical geometry — we propose extends to observer thermodynamics: the rate at which time flows is not intrinsic to spacetime but extrinsic to the observer. Temperature is not something that happens inside time. Temperature is part of what determines how fast time goes.

Version Changelog

- **v9 (March 2026):** Introduces the chart-local speed of time $\Upsilon := dS/d\tau|_{U_T}$ as the new central object. Primary contributions: Definition 4.1 (Υ); Postulate 4.2 (κ-compatible composition via H-function law, inherited from v7/v8.1); Definition 3.1 (observer-filter map $\mathcal{O}_T$); Conjecture 5.1 (isothermal-chart GR recovery, not a derivation); identification of $\Upsilon_{\max}$ with existing invariant bound c_S^{LM} (no new constants); Ansätz 4.4 (gradient form, demoted, not used); Remark 4.3 (algebra identification note, Kaniadakis vs. Livadiotis); four new open problems (O.v9.1–O.v9.4); two new predictions (P.v9.1–P.v9.2); Svintradze [3] introduced as nearest structural neighbour with explicit Clausius/Jaynes ontological firewall; comparison table across CMS, thermodynamic relativity, and Manifold Relativity.

References

[1] Sorvik, P. E. (2026). *Entropy Waves, Coordinate Systems, and the Self-Referential Universe* (v1.0–v8.1). Available: paulsorvik.wordpress.com.

[2] Livadiotis, G., & McComas, D. J. (2024). The theory of thermodynamic relativity. *Scientific Reports*, **14**, 22641. doi:10.1038/s41598-024-72779-0

[3] Svintradze, D. V. (2024). Moving manifolds and general relativity. *arXiv*:2406.08382. arxiv.org/abs/2406.08382

[4] Dvali, G., Gabadadze, G., & Porrati, M. (2000). 4D gravity on a brane in 5D Minkowski space. *Physics Letters B*, **485**, 208–214. doi:10.1016/S0370-2693(00)00669-9

[5] Reingold, O., Vadhan, S., & Wigderson, A. (2002). Entropy waves, the zig-zag graph product, and new constant-degree expanders. *Annals of Mathematics*, **155**, 157–187.

[6] Connes, A. (1994). *Noncommutative Geometry.* Academic Press.

[7] Wigner, E. P., & Yanase, M. M. (1963). Information contents of distributions. *PNAS*, **49**, 910–918.

[8] Parker, D. E. et al. (2019). A universal operator growth hypothesis. *Physical Review X*, **9**, 041017.

[9] Bekenstein, J. D. (1973). Black holes and entropy. *Physical Review D*, **7**, 2333–2346.

[10] Planck Collaboration (2018). Planck 2018 results VI. *Astronomy & Astrophysics*, **641**, A6.

Preprint v9. Introduces the chart-local speed of time $\Upsilon := dS/d\tau|_{U_T}$. Primary contribution: Postulate 4.2 (κ-compatible composition of Υ via H-function law) and identification of the invariant bound $\Upsilon_{\max} = c_S^{\mathrm{LM}}$. GR uniform time recovered as Conjecture 5.1 (isothermal-chart limit, not a derivation). Svintradze CMS introduced as nearest structural neighbour with explicit ontological firewall.

Status: FINAL — approved by full CAC council (Claude, Gemini, ChatGPT nodes).

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