Temporal Horizons and Motion Closure: Time Emergence in Universal Motion Theory

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Abstract

Universal Motion Theory (UMT) proposes that time itself emerges from bounded motion through sufficiently activated curvature fields. This addendum explores the formal structure of time emergence, models behavior near motion closure thresholds, and predicts temporal decoherence effects in low-activation regions. The derivation deepens UMT's philosophical and mathematical foundation without altering its core framework.

1 Introduction

In Universal Motion Theory (UMT), time is not fundamental. It arises only when motion successfully closes through regions of sufficient curvature activation. Where motion cannot close, temporal ordering fails to form, and regions are described as "stillness zones."

This addendum formalizes the concept of temporal horizons: transitional boundaries between activated, time-supporting regions and inactive, timeless zones.

2 Curvature Activation and Motion Closure

The curvature activation function $\Phi(\rho)$ governs the emergence of motion:

$$\Phi(\rho) = \frac{1}{1 + e^{-k(\rho - \rho_{th})}} \tag{1}$$

where k is the steepness parameter and ρ_{th} is the curvature threshold for activation.

Motion closure requires sufficient activation:

$$\text{Motion Closure Condition:} \quad \Phi(\rho) \gtrsim 0.9 \tag{2}$$

Where $\Phi(\rho) \ll 1$, motion remains incomplete, and no resolved time exists.

3 Temporal Horizons

A temporal horizon is defined as the spatial surface where activation transitions across the closure threshold.

Key features:

- **Surface of Transition:** Region where $\Phi(\rho) \sim \Phi_{th}$, near 0.9.
- **Gradient Sharpness:** Controlled by k; sharper gradients produce sharper temporal horizons.
- **Causal Limits:** Beyond the horizon, conventional temporal sequences dissolve.

The local rate of temporal emergence across the horizon is given by:

$$\nabla_t \propto \nabla\Phi \tag{3}$$

where ∇_t denotes the local gradient of temporal resolution.

4 Temporal Decoherence Near Threshold

In regions where $\Phi(\rho)$ approaches but does not surpass the closure threshold, motion may experience:

- **Intermittent closure:** Cyclic or sporadic emergence of time-bearing motion.
- **Temporal decoherence:** Loss of consistent time sequencing, leading to blurred causal structures.

This behavior predicts measurable effects:

- **Suppressed resonance stability** in post-merger systems near activation edges.
- **Local variations in proper time measurements** near strong curvature activation gradients.

5 Philosophical Implications

UMT's framing of time as emergent rather than fundamental leads to:

- **Conditional existence of time:** Time exists only where motion closes.
- **Multiple temporal domains:** Different regions may host distinct temporal emergence properties.
- **Continuity with spacetime structure:** GR-compatible behavior recovers where $\Phi \to 1$.

Temporal horizons offer a natural boundary concept without requiring event horizons or singularities.

6 Conclusion

This addendum formalizes the emergence of time under Universal Motion Theory, introduces the concept of temporal horizons, and predicts measurable decoherence effects near activation thresholds. It reinforces UMT's foundational axiom that time arises from the closure of motion through activated curvature fields.

References

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3. Carroll, S. M. (2004). Spacetime and Geometry: An Introduction to General Relativity.