Two Minimal Falsification Attempts for CTMT

Coherence-Weighted Trigonometry and Rupture as a Pre-Fit Diagnostic

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Abstract

We present two orthogonal, self-contained falsification attempts targeting distinct structural commitments of Chronotopic Metric Theory (CTMT). *Pillar A* tests the claim that Euclidean trigonometry arises only as the uniform-coherence limit of coherence-weighted Fisher geometry. *Pillar D* tests a model-free rupture statistic intended as a conservative, pre-fit diagnostic of transport incoherence. Both tests are deliberately minimal, require no global model fitting, and are designed to fail whenever CTMT's distinguishing predictions do not hold.

1 Minimal Assumptions (Common to Both Pillars)

1. Observables are scalar or vector measurements defined on a Euclidean embedding space but physically realized along causal transport paths.
2. Coherence γ and propagation speed c are positive and bounded, and may vary spatially.
3. All statistics are computed *prior* to any global model fitting or parametric assumptions.

No external constants (e.g. CODATA) or postulated background geometries are used.

2 Pillar A: Coherence-Weighted Trigonometry

2.1 Falsifiable Claim

Claim. If coherence and propagation speed are spatially uniform, CTMT trigonometry *must* reduce exactly to Euclidean trigonometry (up to floating-point precision). If they are heterogeneous, Euclidean angles become scene-dependent, while CTMT angles remain operationally well defined.

Failure of either condition falsifies the claim.

2.2 Geometric Setup

Let $P, Q, R \in \mathbb{R}^2$ define a triangle.

CTMT path length.

$$d_{\mathrm{CTMT}}(P, Q) = \int_{P \to Q} \Omega \, \frac{\gamma(x, y)}{c(x, y)} \, ds. \tag{1}$$

CTMT cosine law. Given CTMT side lengths (a, b, c), the angle at P is

$$\cos_{\mathrm{CTMT}} \alpha = \frac{b^2 + c^2 - a^2}{2bc}. \tag{2}$$

Euclidean comparator. The classical angle α_E is computed from vectors $\vec{PQ}$ and $\vec{PR}$.

2.3 Scenes

- **Uniform scene:**

$$c(x, y) = c_0, \qquad \gamma(x, y) = \gamma_0.$$

- **Heterogeneous scene:**

$$c(x, y) = c_0[1 + 0.30 \sin(x/L_x)], \qquad \gamma(x, y) = \gamma_0[1 + 0.50 \cos(y/L_y)].$$

Two hundred triangles were sampled uniformly in each scene.

2.4 Results

Table 1: Pillar A — Uniform Scene (200 triangles)

Quantity	Mean	Median	Std. dev.
$\lvert\alpha_{\mathrm{CTMT}} - \alpha_E\rvert$ (deg)	9.9×10^{-14}	0	1.1×10^{-13}
$\lvert\cos_{\mathrm{CTMT}} - \cos_E\rvert$	2.7×10^{-16}	0	3.4×10^{-16}

Observation. Euclidean trigonometry is recovered to machine precision without adjustable parameters.

Table 2: Pillar A — Heterogeneous Scene (200 triangles)

Quantity	Mean	Median	Std. dev.
$\lvert\alpha_{\mathrm{CTMT}} - \alpha_E\rvert$ (deg)	15.37	11.74	20.19
$\lvert\cos_{\mathrm{CTMT}} - \cos_E\rvert$	0.182	0.141	0.236

Interpretation. Large, stable departures appear when coherence is non-uniform. Euclidean angles become configuration-dependent, while CTMT angles remain internally consistent.

2.5 Falsification Status

- **Uniform scene:** survives; failure would have falsified CTMT.
- **Heterogeneous scene:** Euclidean invariance is falsified.

3 Pillar D: Rupture as a Pre-Fit Diagnostic

3.1 Falsifiable Claim

Claim. A MAD-normalized second-difference statistic detects strong transport ruptures but remains conservative when curvature changes are weak relative to noise.

False positives falsify the claim.

3.2 Statistic

Given a scalar series Y_k,

$$\Delta^2 Y_k = Y_{k+1} - 2Y_k + Y_{k-1}, \tag{3}$$

$$R_k = \frac{\Delta^2 Y_k - \text{median}}{1.4826\,\text{MAD}}. \tag{4}$$

Flag a rupture if $|R_k| > 3.5$.

3.3 Test Design

- Length: $n = 240$
- Signal: piecewise quadratic with a single slope kink near $k_0 = 120$
- Noise: additive Gaussian
- Variants tested:
    1. raw series
    2. rebin by factor 2
    3. 3-point smoothing

3.4 Results

Table 3: Pillar D — Rupture Statistics (All Variants)

Variant	$\max \lvert R_k \rvert$	Rupture flagged?
Raw	< 2.8	No
Rebinned (2)	< 2.5	No
Smoothed	< 2.6	No

Observation. No false positives occur under any preprocessing.

3.5 Falsification Status

The statistic behaves conservatively. A positive detection here would have falsified the claim. None occurs.

4 Positive Pillar D Demonstration (Strong Rupture)

To complement the conservative tests above, we include a positive control in which a deliberately stronger kink is introduced. The goal is to verify that the rupture statistic responds consistently across raw, rebinned, and smoothed variants, and that a genuine transport rupture produces a persistent threshold crossing $|R_k| > 3.5$.

4.1 Setup

We retain the same length ($n = 240$) and noise model as in the conservative tests, but increase the curvature discontinuity at $k_0 = 120$ by a factor of five. No other parameters are changed.

Table 4: Pillar D — Positive Control (Stronger Kink)

Variant	$\max \lvert R_k \rvert$	Rupture flagged?
Raw	5.8	Yes
Rebinned (2)	4.9	Yes
Smoothed	4.6	Yes

4.2 Results

Observation. All three preprocessing variants exceed the rupture threshold $|R_k| > 3.5$ at the same location (within ± 1 index), and the detection persists under rebinning and smoothing. This confirms that the statistic is sensitive to genuine curvature discontinuities while remaining robust to mild preprocessing.

4.3 Falsification Status

A failure to detect the rupture in any of the three variants would have falsified the claim. All variants succeed, and the detection is stable.

5 Discussion

Pillar A tests CTMT's coherence-weighted geometry and shows that Euclidean trigonometry is recovered only in the uniform-coherence limit. Pillar D tests a conservative rupture gate and confirms that it does not overreact to weak curvature changes.

The two pillars are independent: failure of one does not rescue the other.

6 Conclusion

These two tests form a minimal, low-friction falsification package: one geometric and one statistical. Both are reproducible with table-top data and impose strong constraints without requiring global model fitting or external constants.