SRT Part II: PRE-REGISTRATION

SRT Complexity Correlation Test (SN Ia + Weak Lensing)

LiMiT

February 2026

Abstract

This document serves as a formal pre-registered falsification protocol for the State-Rewrite Theory (SRT). It defines fixed observables, models, and thresholds designed to isolate any SRT-specific signal from standard General Relativity (GR) + ΛCDM weak-lensing effects. The protocol establishes that the proposed SRT mechanism is empirically falsifiable and locks all statistical parameters prior to analysis.

1 Ground Truth: GR + ΛCDM Expectations

GR + ΛCDM weak-lensing magnification implies a measurable dependence between SN Ia Hubble residuals and line-of-sight convergence. The null hypothesis is not $r = 0$, but rather that observed dependencies are fully explained by standard magnification, selection, and survey systematics.

This baseline has been empirically detected in multiple datasets, notably in Pantheon (3.6σ, see e.g., Shah et al. 2024) and DES-SN5YR (high significance). This protocol aims to separate:

(A) The standard mean magnification channel.

(B) Any additional complexity-driven variance channel specific to SRT.

2 Observables and Sign Conventions (Frozen)

Primary Observable: Standardized SN Ia distance-modulus residuals:

$$\mu_{res,i} = \mu_{obs,i} - \mu_{\Lambda CDM,i}$$

Computed after standard light-curve standardization and selection corrections. Positive μ_{res} indicates the SN appears dimmer than predicted.

Uncertainty Term: $\sigma_{\mu,i}$ (published per-supernova uncertainty) used to normalize variance tests.

Predictors: Derived from line-of-sight weak-lensing tomography $\kappa_i(z)$:

- **Mean-Shift ($\kappa_{eff,i}$):** Weighted sum/mean of convergence along the line-of-sight (LOS).
- **Complexity (K_i):** Multi-plane variance across tomographic bins, $K_i = Var_z[\kappa_i(z)]$.

$\kappa(z)$ **Estimation Protocol:** $\kappa_i(z)$ is computed from a fixed mass-map product using a 10 arcmin aperture and Gaussian smoothing ($\sigma = 5$ arcmin). *If the κ map product is already smoothed/binned by the release, we use the release-native smoothing/bins and do not re-smooth; the aperture/smoothing defaults apply only when κ is computed directly from a raw mass-map.*

3 The Dual-Channel Test (Fixed Models)

Validation requires passing two distinct endpoints:

3.1 Endpoint A: Mean-Shift (Baseline Lensing)

$$\mu_{res,i} = a + \gamma_1 \kappa_{eff,i} + b_1 z_i + b_2 HostMass_i + \text{SurveyIndicators} + \epsilon_i$$

GR Expectation: $\gamma_1 < 0$. Overdense LOS magnifies, making SNe appear brighter, reducing μ_{res}.

3.2 Endpoint B: Complexity/Scatter (SRT Channel)

Define the normalized variance proxy $y_i = (\mu_{res,i}/\sigma_{\mu,i})^2$:

$$y_i = a + \gamma_2 K_i + \delta \kappa_{eff,i} + b_1 z_i + b_2 HostMass_i + \text{SurveyIndicators} + \epsilon_i$$

SRT Requirement: $\gamma_2 > 0$. Higher LOS complexity predicts additional normalized residual variance beyond baseline magnification. $HostMass_i$ is included as a systematics check even if already corrected for in the primary pipeline.

4 Tiered Monotonicity

Samples are binned by K (Complexity) quantiles. The tier means of y must increase monotonically:

- **Tier 1:** Lowest 20% K (Baseline).
- **Tier 4:** Top 5% K (Extreme tail).
- **Threshold:** Tier 1 vs. Tier 4 separation must exceed 3σ via bootstrap.

5 No-Escape Clause

The SRT mechanism is rejected if:

1. γ_2 is consistent with zero or the 95% CI includes 0.
2. Tier monotonicity fails or the 3σ separation threshold is not met.
3. The γ_2 effect collapses when controlling for κ_{eff}.
4. The sign of γ_2 does not replicate across independent datasets.

Document Hash: SRT-PREREG-V2-K-TEST-2026-LiMiT