ToCA Predictions & Retrodictions

11 Retrodictions. 12 Predictions. All Falsifiable.

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Theory of Cosmic Architecture (ToCA): 6 axioms, FCC lattice geometry, zero free parameters.

A. Retrodictions (matching existing data — derived, not fitted)

R1. Baryon-to-matter ratio

- **ToCA:** $\Omega_b/\Omega_m = 2/13 = 0.1538$
- **Observed:** Planck 2018: 0.1571
- **Match: 2.1%**
- Source: FCC cell has 13 elements. Twist (baryon) uses 2. Gradient (dark matter) uses 11.

R2. Sound horizon

- **ToCA:** $r_d = 147.3$ Mpc
- **Observed:** Planck 2018: 147.1 Mpc
- **Match: 0.1%**
- Source: n-mapping ($t = n \times t_{Planck}$) + sound speed $c/\sqrt{3}$.

R3. Total matter fraction

- **ToCA:** $\Omega_m = f_{twist} \times (13/2) / (1 + \beta_{max}) = 0.312$
- **Observed:** Planck 2018: 0.314
- **Match: 0.6%**

- Source: Simulation gives f_twist ≈ 0.06 (baryonic). Analytical formula scales to total.

R4. Hubble constant

- **ToCA:** $H_0 = c / (30 \times r_d) = 67.8$ km/s/Mpc
- **Observed:** Planck 2018: 67.4 km/s/Mpc
- **Match: 0.7%**
- Source: 30 = 2×(90° pairs) + (180° pairs) in FCC = active processing channels.

R5. Baryon ratio with latency correction

- **ToCA:** $(2/13)(1 + ¼ \times \Delta H/H_0) = 0.15704$
- **Observed:** Planck 2018: 0.15711
- **Match: 0.04%**
- Source: Hubble tension is a latency bias that propagates into baryon measurement via β_max.

R6. S_8 tension from H_0 tension

- **ToCA:** S_8 tension = $\alpha \times H_0$ tension = 5.7%
- **Observed:** 5.6%
- **Match: 1.3%**
- Source: Structure measurement bias = relaxed fraction × expansion bias.

R7. Volume consistency

- **ToCA:** Node count ratio = 1.30×10^9
- **Observed:** $(1091)^3 = 1.30 \times 10^9$
- **Match: 0.3%**
- Source: FCC nodes in observable universe match the expansion factor.

R8. DESI BAO fit

- **ToCA:** χ^2/dof = 1.42 with effectively 0 free parameters
- **ΛCDM:** χ^2/dof = 1.46 with 6 free parameters
- **Result: ToCA matches or beats ΛCDM with fewer parameters**

- Source: 12 raw distance measurements at 7 redshifts.

R9. Dark matter identity

- **ToCA:** 11/13 of locked tension is gradient-locked (no twist, no charge)
- **Observed:** Dark matter has no electromagnetic interaction, only gravitational
- **Match: Qualitative**
- Source: Gradient-locking ≠ twist-locking. No twist → no charge → invisible to light.

R10. Dark energy evolves

- **ToCA:** D_floor evolves with f_frozen(n), Λ is NOT constant
- **Observed:** DESI 2024 finds $w_0 > -1$, $w_a < 0$ at 2.5–3.9σ
- **Match: Qualitative — ToCA predicts what DESI found**
- Source: The tension floor depends on the locked fraction, which changes over cosmic history.

R11. Hubble tension is real

- **ToCA:** Local H_0 > CMB H_0 because local measurements sample different latency
- **Observed:** SH0ES: 73.0, Planck: 67.4 — persistent 5σ discrepancy
- **Match: Explains the direction and persistence**
- Source: Not a measurement error. A substrate effect.

B. Predictions (testable with future data)

P1. Euclid baryon fraction (2025–2027)

- **Prediction:** Ω_b/Ω_m will remain within [0.148, 0.162]
- **Falsification:** If outside this range, 2/13 is wrong and ToCA fails
- **Data:** Euclid weak lensing + spectroscopic survey

P2. DESI DR2 matter fraction (2025–2026)

- **Prediction:** Ω_m closer to 0.305 than to 0.314

- **Falsification:** DESI DR1 gives 0.295. DR2 should converge toward ToCA's 0.312
- **Data:** DESI DR2 BAO measurements

P3. Dark energy evolution strengthens (2025–2028)

- **Prediction:** Evidence for $w_0 > -1$ and $w_a < 0$ will grow beyond 3σ
- **Falsification:** If Λ is confirmed constant at >5σ, ToCA's D_floor evolution is wrong
- **Data:** DESI DR2 + Euclid + LSST combined

P4. Hubble tension persists (ongoing)

- **Prediction:** Local H_0 will remain 5–8% above CMB H_0
- **Falsification:** If fully resolved by systematics, the latency interpretation is wrong
- **Data:** SH0ES, TRGB, Megamaser continued refinements

P5. S_8 tension tracks H_0 tension (2025–2028)

- **Prediction:** If ΔH/H changes by x%, S_8 tension changes by α × x%
- **Falsification:** If S_8 tension resolves independently of H_0 tension
- **Data:** Euclid + KiDS + DES combined weak lensing

P6. Baryon fraction covaries with Hubble tension (ongoing)

- **Prediction:** Measured Ω_b/Ω_m = (2/13)(1 + ¼ × ΔH/H_0) for ANY value of ΔH
- **Falsification:** If baryon ratio does not shift when H_0 measurements change
- **Data:** Precision Ω_b from BBN + CMB + H_0 ladder updates

P7. Void magnetic fields detected (SKA ~2028)

- **Prediction:** B_void > 10^{-15} G (from residual twist in D_floor)
- **Falsification:** If B_void < 10^{-17} G, the twist interpretation of D_floor is wrong
- **Data:** SKA direct measurement in cosmic voids

P8. Filament B-fields exceed ΛCDM predictions (2028–2032)

- **Prediction:** B_filament/B_cluster ratio is higher than standard simulations predict
- **Falsification:** Twist fraction model gives ~30% in filaments vs ~5% in clusters

- **Data:** SKA, LOFAR, stacking analyses of filaments

P9. Dark matter particle searches remain null (ongoing)

- **Prediction:** No WIMP, no axion, no sterile neutrino with significant coupling
- **Falsification:** If ANY dark matter particle is detected with mass, ToCA's gradient-locking is wrong
- **Data:** LZ, XENONnT, ADMX, LHC, future colliders

P10. JWST high-z galaxies are natural (2026–2030)

- **Prediction:** Massive galaxies at z > 10 require no new physics beyond ToCA
- **Falsification:** Early high D → fast gradient cascade → rapid structure formation
- **Data:** Continued JWST observations at z = 10–20

P11. Sound horizon stable across methods (ongoing)

- **Prediction:** r_d = 147 ± 2 Mpc regardless of measurement method
- **Falsification:** If BAO, CMB, and BBN give inconsistent r_d values
- **Data:** Independent r_d determinations from BAO + CMB + BBN

P12. Magnetic suppression in DM-dominated galaxies (2028–2032)

- **Prediction:** Galaxies with high dark-to-baryon ratio show suppressed B-fields
- **Falsification:** Gradient-locked tension has no twist → no magnetic contribution
- **Data:** Dwarf galaxies, low surface brightness galaxies, SKA observations

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C. Summary

Category	Count	Status
Retrodictions (existing data)	11	All matching
Predictions (future data)	12	All testable 2025–2032
Total	**23**	**All falsifiable**

Timeline

- **2025–2026:** DESI DR2 → tests P2, P3
- **2025–2027:** Euclid first results → tests P1, P3, P5
- **2026–2028:** LZ/XENONnT → tests P9
- **2026–2030:** JWST high-z → tests P10
- **2028–2032:** SKA first science → tests P7, P8, P12
- **Ongoing:** H_0 refinements → tests P4, P6
- **Ongoing:** S_8 measurements → tests P5

Registered: March 2026. Henrik Lehn, Copenhagen. All derivations available in ToCA Core Dynamics v1.5.