Experimental Test Program for 3D+3D Discrete Spacetime Theory

A Roadmap for Observational and Laboratory Verification

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Executive Summary

The 3D+3D Discrete Spacetime Theory makes specific, quantitative, falsifiable predictions across multiple experimental domains. This document outlines a comprehensive test program spanning:

1. **Cosmological observations** (Euclid, DESI, PTA) — Immediate
2. **Collider searches** (LHC, FCC) — Near-term
3. **Precision gravity experiments** — Medium-term
4. **Dedicated laboratory tests** — Long-term

Each test is designed to either **confirm** or **falsify** specific predictions of the theory.

PART I: COSMOLOGICAL TESTS (2025-2030)

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1. Euclid Space Mission

1.1 Pre-Registered Predictions

The following predictions are registered **before** Euclid DR1 release:

Prediction E1: Cosmic Web Harmonic Scales

The correlation function ξ(r) should show features at the harmonic scales:

Scale	Value	Origin
λ_{13}	0.856 ± 0.030 Mpc	Filament characteristic radius
λ_{14}	1.385 ± 0.050 Mpc	Supercluster scale
λ_{15}	2.24 ± 0.08 Mpc	Void characteristic size

Test criterion: Detection of excess correlation at r = λ_{13} with significance > 3σ.

Prediction E2: BAO Feature Modification

The BAO peak at ~150 Mpc should show a secondary feature at:

$$r_{secondary} = r_{BAO}/\varphi^k \quad \text{for integer } k$$

Specifically:

- 150 / φ² ≈ 57 Mpc (k=2)
- 150 / φ³ ≈ 35 Mpc (k=3)

Test criterion: Detection of sub-BAO features with correct φ-spacing.

Prediction E3: Weak Lensing Power Spectrum

The convergence power spectrum P_κ(ℓ) should show:

$$\frac{P_\kappa^{3D3D}(\ell)}{P_\kappa^{\Lambda CDM}(\ell)} = 1 + \alpha_2 f\left(\frac{\ell}{\ell_{\lambda_2}}\right)$$

where ℓ_λ_2 corresponds to angular scale θ ~ λ_2/D_A.

1.2 Analysis Protocol

1. Download public Euclid DR1 data
2. Compute 2-point correlation function ξ(r)
3. Search for features at predicted λ_n scales
4. Compare with null hypothesis (ΛCDM smooth)
5. Publish result regardless of outcome

1.3 Falsification Criteria

The theory is **falsified** if:

- No features detected at λ_{13} scale (> 3σ exclusion)
- Features detected at scales incompatible with φ-ladder
- BAO modification absent at predicted level

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2. DESI Survey

2.1 Pre-Registered Predictions

Prediction D1: Galaxy Clustering Bias

The linear bias b(z) should show scale-dependence:

$$b(k, z) = b_0(z) \times \left[1 + \beta_Q \sin^2\left(\frac{\pi k \lambda_2}{2}\right)\right]$$

with $\beta_Q \approx 0.03$-0.05.

Prediction D2: Redshift-Space Distortions

The growth rate $f(z)\sigma_8(z)$ measured from RSD should differ from ΛCDM:

$$\frac{f\sigma_8^{3D3D}}{f\sigma_8^{\Lambda CDM}} = 1 + \gamma_Q(z)$$

where $\gamma_Q(z)$ is predicted from Q-field evolution.

2.2 Data Products Needed

- Galaxy power spectrum P(k) at multiple redshifts
- Correlation function ξ(s, μ) in redshift space
- BAO measurements
- Full shape analysis results

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3. Pulsar Timing Arrays

3.1 Pre-Registered Predictions

Prediction P1: Period Ratio Refinement

The temporal oscillation periods should refine to:

$$T_2 = 30.0 \pm 0.5 \text{ years}$$

$$T_3 = 19.0 \pm 0.3 \text{ years}$$

$$T_2/T_3 = 1.579 \pm 0.02 \approx \varphi$$

Prediction P2: Hellings-Downs Modification

The angular correlation of PTA residuals should show:

$$\Gamma(\theta) = \Gamma_{HD}(\theta) + \epsilon_Q \Gamma_Q(\theta)$$

with ε_Q ~ 0.01 from Q-field background.

3.2 Data Sources

- NANOGrav 15-year dataset (public)
- EPTA DR2
- PPTA DR3
- IPTA combined analysis

PART II: COLLIDER TESTS (2025-2040)

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4. LHC Searches

4.1 The Distinctive 3D+3D Signature

Unlike ADD or RS models, the 3D+3D theory predicts a **double KK tower** with specific mass ratios:

$$\boxed{\frac{M_{(0,1)}}{M_{(1,0)}} = \frac{1}{\varphi} \approx 0.618}$$

This is a **smoking gun** signature distinguishing 3D+3D from other extra dimension models.

4.2 Search Channels

Channel 1: Diphoton resonances

- Process: pp → G_KK → γγ
- Mass range: 1-10 TeV
- Current limit: M > 4.5 TeV

Channel 2: Dilepton resonances

- Process: pp → G_KK → $\ell^+\ell^-$
- Mass range: 1-10 TeV
- Current limit: M > 4.0 TeV

Channel 3: Dijet resonances

- Process: pp → G_KK → jj
- Larger cross-section but more background

4.3 Proposed Analysis

Step 1: If a resonance is found at mass M_1, search for second resonance at:

- $M_2 = M_1 \times 0.618$ (if M_1 is the heavier state)
- $M_2 = M_1 \times 1.618$ (if M_1 is the lighter state)

Step 2: Measure the mass ratio with precision $\Delta(M_2/M_1) < 5\%$

Step 3: Compare with prediction $1/\varphi = 0.6180339...$

4.4 Contact Points

Collaboration	Group	Contact
ATLAS	Exotics	exotics-conveners@cern.ch
CMS	B2G	b2g-conveners@cern.ch
Theory	Extra Dimensions	(various)

4.5 Falsification Criteria

The theory is **falsified** if:

- Single resonance found without partner at predicted mass
- Two resonances found with ratio ≠ 0.618 or 1.618 (> 3σ)
- KK graviton couplings inconsistent with 6D prediction

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5. Future Colliders (FCC-hh)

5.1 Extended Mass Reach

FCC-hh at √s = 100 TeV would probe:

- KK graviton masses up to ~50 TeV
- Multiple KK levels (n_2, n_3) = (1,0), (0,1), (1,1), (2,0), ...

5.2 Full Spectrum Measurement

With sufficient luminosity, FCC could measure the **complete KK spectrum**:

Mode	**Mass (if M_{10} = 5 TeV)**
(1,0)	5.00 TeV
(0,1)	3.09 TeV
(1,1)	5.88 TeV
(2,0)	10.00 TeV
(0,2)	6.18 TeV

This would provide an **over-constrained** test of the theory.

PART III: PRECISION GRAVITY TESTS (2025-2035)

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6. Equivalence Principle Tests

6.1 MICROSCOPE Results

The MICROSCOPE satellite tested the Weak Equivalence Principle to:

$$\eta = (-1.5 \pm 2.8) \times 10^{-15}$$

The 3D+3D theory predicts:

$$\eta_{3D3D} \sim \alpha_2 \left(\frac{r_{orbit}}{\lambda_2}\right)^2 \sim 10^{-20}$$

This is **below** current sensitivity but sets a consistency check.

6.2 Future Missions: STEP

The proposed STEP mission would reach η ~ 10⁻¹⁸, approaching the predicted level.

6.3 Atom Interferometry

Ground-based atom interferometers (Stanford, MAGIS) could probe intermediate scales:

$$\delta g/g \sim 10^{-15} \text{ at } r \sim 10 \text{ m}$$

The 3D+3D prediction at this scale:

$$\frac{\delta g}{g} \sim \alpha_2 \sin^2\left(\frac{\pi r}{2\lambda_2}\right) \sim 10^{-20}$$

Still below sensitivity, but future improvements may reach this.

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7. Gravitational Wave Observations

7.1 LIGO/Virgo/KAGRA

Prediction: Standard GR waveforms for stellar-mass mergers (suppression 10⁻¹⁴).

Test: Confirm no anomalies in inspiral phase — CONSISTENT ✓

7.2 LISA (2030s)

Prediction: EMRI dephasing at level δΦ ~ 10⁻⁵ rad over 10⁵ cycles.

Test: Precision measurement of EMRI waveforms.

7.3 PTA Angular Correlations

Prediction: Hellings-Downs modification at ~1% level.

Test: Compare measured Γ(θ) with GR prediction.

PART IV: DEDICATED LABORATORY EXPERIMENTS (Long-term)

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8. Q-Field Detection Concepts

8.1 The Challenge

Direct Q-field detection is extremely challenging because:

- Screening length $\lambda_2 \sim$ kpc >> laboratory scales
- Q-field mass $m_Q \sim 10^{-26}$ eV → Compton wavelength ~ kpc
- Coupling suppressed by M_P

8.2 Resonant Enhancement

Concept: Use resonant cavity to enhance Q-field oscillations at frequency:

$$f_Q = \frac{c}{\lambda_2} \sim 10^{-11}\ \text{Hz}$$

This corresponds to period T ~ 3000 years — not practical.

8.3 KK Mode Detection

The KK modes at TeV scale could couple to:

- High-energy photons
- Electron beams
- Nuclear transitions

Concept: Search for missing energy in high-precision calorimetry at electron accelerators.

8.4 Casimir Effect Modification

The Casimir force between plates should be modified at separation:

$$d \sim R^{geom} \sim 10^{-19}\ \text{m}$$

This is far below measurable scales (current limit $d \sim 10^{-8}$ m).

9. Indirect Tests via Nuclear/Atomic Physics

9.1 Neutron EDM

Prediction: $d_n \sim 10^{-32}$ e·cm (from Q-field CP violation)

Current limit: $d_n < 10^{-26}$ e·cm

Future sensitivity: nEDM@SNS aims for 10^{-28} e·cm

Still 4 orders of magnitude away, but approaching.

9.2 Atomic Parity Violation

Q-field effects could modify atomic parity violation at level:

$$\delta Q_W / Q_W \sim 10^{-10}$$

Below current precision but potentially measurable with next-generation experiments.

PART V: IMPLEMENTATION TIMELINE

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10. Phased Approach

Phase 1: Immediate (2025)

Action	Timeline	Resources
Pre-register Euclid predictions	December 2025	Zenodo upload
Pre-register DESI predictions	December 2025	Zenodo upload
Contact NANOGrav collaboration	Q1 2025	Email
Submit theory paper to journal	Q1 2025	arXiv + journal

Phase 2: Near-term (2025-2027)

Action	Timeline	Resources
Analyze Euclid DR1	When released	Computing
Analyze DESI DR2	When released	Computing
Contact LHC experimentalists	2025-2026	Collaboration

Action	Timeline	Resources
Write collider phenomenology paper	2026	Theory work

Phase 3: Medium-term (2027-2030)

Action	Timeline	Resources
Full Euclid analysis	2027-2028	Computing
LISA predictions paper	2028	Theory work
Atom interferometry proposal	2029	Collaboration

Phase 4: Long-term (2030+)

Action	Timeline	Resources
FCC phenomenology	2030s	Theory work
Dedicated Q-field experiment	TBD	Major funding

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11. Resource Requirements

11.1 What We Can Do Now (No Funding)

- Pre-register predictions ✓
- Analyze public data ✓
- Write papers ✓
- Contact collaborations ✓

11.2 What Requires Collaboration

- LHC data analysis (need experimentalist partners)
- PTA detailed analysis (need PTA collaboration)
- Euclid proprietary data (need Euclid membership)

11.3 What Requires Funding

- Dedicated laboratory experiments
- Computing resources for large simulations
- Travel for collaboration meetings

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12. Success Metrics

12.1 Theory Confirmation

The theory is **confirmed** if:

- ≥3 independent predictions verified at >3σ
- No predictions falsified at >3σ
- KK graviton mass ratio measured as 0.618 ± 0.05

12.2 Theory Falsification

The theory is **falsified** if:

- Any prediction contradicted at >5σ
- Fundamental inconsistency discovered
- Alternative explanation found for all "confirmations"

12.3 Ongoing Assessment

We commit to:

- Publishing ALL results (positive and negative)
- Updating predictions based on new data
- Acknowledging limitations and uncertainties
- Welcoming criticism and alternative analyses

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13. Conclusion

The 3D+3D theory makes **specific, quantitative, falsifiable predictions** across multiple experimental domains. We have outlined a comprehensive test program that can:

1. **Immediately** test cosmological predictions (Euclid, DESI, PTA)
2. **Near-term** search for KK gravitons at LHC
3. **Medium-term** probe precision gravity effects
4. **Long-term** develop dedicated laboratory tests

The theory stands ready for experimental judgment.

> *"The great thing about science is that it's true whether or not you believe in it."* — Neil deGrasse Tyson

We believe. Now let's test.

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Next Review: Upon Euclid DR1 release

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Appendix A: Contact List

Cosmology Collaborations

Collaboration	Contact Point	Status
Euclid	science@euclid-ec.org	To contact
DESI	desi-collab@lbl.gov	To contact
NANOGrav	contact@nanograv.org	To contact

Particle Physics

Collaboration	Contact Point	Status
ATLAS Exotics	CERN	To contact
CMS B2G	CERN	To contact

Gravity Experiments

Experiment	Contact Point	Status
MICROSCOPE	CNES/ONERA	Results published
MAGIS	Stanford	To contact
nEDM@SNS	ORNL	To contact

Appendix B: Pre-Registered Predictions Summary

Cosmological Scales

Prediction	Value	Uncertainty	Test
λ_{13}	0.856 Mpc	±0.030 Mpc	Euclid $\xi(r)$

Prediction	Value	Uncertainty	Test
λ_{14}	1.385 Mpc	±0.050 Mpc	Euclid ξ(r)
T_2/T_3	1.579	±0.02	NANOGrav

Collider Physics

Prediction	Value	Uncertainty	Test
M_2/M_1 ratio	0.618	±0.05	LHC diphoton
M_KK range	1-10 TeV	—	LHC searches

Cosmological Parameters

Prediction	Value	Uncertainty	Test
n_s	0.965	±0.005	Planck/Euclid
r	0.01-0.05	—	CMB B-modes
η_B	6×10^{-10}	±10%	BBN/CMB

End of Experimental Test Program Document