# Observational Constraints and Experimental Tests of Holosphere Theory

Michael John Sarnowski

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**Abstract**

We present a framework for empirical validation of the Holosphere Theory—a discrete, spinning lattice model of spacetime in which gravitational and quantum phenomena arise from spin tension, orbital misalignment, and defect condensation. Building on prior theoretical development, this paper focuses on falsifiable predictions that distinguish the Holosphere model from ΛCDM cosmology and standard quantum mechanics. Key predictions include surface brightness dimming as $(1+z)^{-3}$, redshift-distance behavior without dark energy, non-monotonic lensing asymmetries, and decoherence thresholds tied to spin strain. These tests span astrophysical surveys, interferometry, and quantum measurement. Our aim is to transition from ontological structure to observational engagement—providing specific predictions that may confirm or falsify this discrete cosmological model.

# Contents

# 1 Introduction: From Ontology to Observation

The Holosphere Theory proposes a radical rethinking of the fabric of reality—not as a smooth spacetime manifold or a probabilistic wavefunction field, but as a discrete, spinning lattice of tightly packed geometric units called Holospheres. Within this framework, quantum particles emerge from vacancy defects in the lattice, while gravitational and cosmological phenomena arise from spin tension gradients, orbital phase reconfiguration, and large-scale alignment collapse.

Over the course of the preceding six papers, we developed this theory from first principles. We modeled the electron as a coherent triplet of dark bosons [**?**], explored the mechanisms of decoherence and thermalization [**?**], and explained gravitation as a byproduct of rotational tension gradients caused by defect clustering [**?**]. Redshift was derived in Paper 11 as a hybrid effect—emerging from relativistic medium motion and exponential phase drag—without the need for comoving distances or dark energy [**?**].

These conceptual advances are unified by a single ontological premise: that matter, motion, and measurement all arise from the discrete reconfiguration of coherent orbital modes within a structured, rotating medium. However, a complete theory must be testable.

In this seventh paper, we shift from theoretical construction to empirical validation. We examine where Holosphere Theory makes predictions that diverge from both ΛCDM cosmology and standard quantum mechanics, and we outline observational and experimental pathways to test those predictions. These include:

- Surface brightness dimming as $(1+z)^{-3}$, rather than $(1+z)^{-4}$,
- Redshift-distance scaling matching ΛCDM without requiring inflation, dark matter, or a comoving metric,
- Subtle asymmetries in gravitational lensing patterns,
- Time dilation effects deviating from standard expectations at high redshift,
- Quantum decoherence thresholds in high-strain or curved environments,
- Bell test angular deviations under controlled orbital misalignment.

In particular, we highlight the testable consequences of treating redshift and gravitation as geometric phase effects in a discrete medium, rather than phenomena of field propagation in continuous spacetime.

The goal of this paper is not only to present predictions, but to outline specific astronomical surveys, interferometry experiments, and gravitational coherence tests capable of confirming or falsifying Holosphere Theory. This transition—from ontology to observation—marks a critical phase in the development of the model and offers a roadmap toward scientific engagement.

## 2 Summary of Unique Predictions

The Holosphere Theory provides a unified geometric ontology that differs fundamentally from both standard cosmology and orthodox quantum mechanics. As a result, it yields distinct, falsifiable predictions across multiple observational and experimental domains. These differences arise from the core premises of the theory: that spacetime is discrete, rotational, and composed of phase-coherent Holospheres; that gravitation is a manifestation of angular tension gradients; and that redshift and measurement are outcomes of orbital alignment reconfiguration rather than field dynamics.

The table below summarizes where Holosphere Theory departs from existing paradigms and identifies potential observables that can differentiate it from ΛCDM and standard QM:

| **Phenomenon** | **ΛCDM / Standard QM** | **Holosphere Theory Prediction** | |
|---|---|---|---|
| Redshift Origin | Metric expansion, Doppler | Spiral phase slippage + Doppler | |
| Surface Brightness | $(1+z)^{-4}$ | $(1+z)^{-3}$ | |
| Angular Size | Minimum at $z \sim 1.5$ | Monotonic inverse scaling | |
| Gravitational Lensing | Curved spacetime paths | Orbital phase gradients | L |
| Dark Matter | New non-baryonic mass sector | Tension shells from defect gradients | Ro |
| Dark Energy | Cosmological constant | Exponential phase drag from spin strain | |
| Time Dilation | Due to expansion | Due to kinetic tension gradients | |
| Inertia | Fundamental property of mass | Gradient of orbital phase entanglement | Devi |
| Entanglement | Nonlocal wavefunction collapse | Shared orbital mode phase collapse | Be |
| Decoherence | Environmental entanglement | Orbital misalignment and phase tension | I |

These distinctions define the empirical edge of the theory. Many of the Holosphere predictions align with existing data—particularly for redshift and surface brightness—but also suggest small, testable deviations that are just within reach of current or near-future observational capabilities.

In the sections that follow, we explore each of these predictions in depth, propose observational or experimental methodologies to test them, and identify where Holosphere Theory can be decisively confirmed or ruled out.

## 3 Surface Brightness Tests and Tolman Scaling

The Tolman surface brightness test offers a powerful observational tool for distinguishing between cosmological models. In the standard ΛCDM framework, the bolometric surface brightness of galaxies (brightness per unit angular area) is expected to dim with redshift as:

$$S \propto (1+z)^{-4}$$

This result arises from three effects: time dilation reducing the photon arrival rate by $(1+z)$, redshift reducing each photon's energy by another factor of $(1+z)$, and the apparent area expanding as $(1+z)^2$. However, the Holosphere model predicts a different redshift-scaling behavior due to the geometry of light propagation through a rotating lattice.

In the Holosphere framework, the universe is not expanding, but light travels through a medium with cumulative angular strain. The attenuation results primarily from phase slippage and geometric divergence of orbital alignment rather than redshifted energy loss due to metric expansion.

We derive a surface brightness dimming law of:

$$S \propto (1+z)^{-3}$$

This scaling originates from three components:

- Energy redshift from phase drag: $(1+z)^{-1}$
- Photon arrival time dilation due to kinetic delay through tension gradients: $(1+z)^{-1}$
- Geometric spreading of light across angular divergence in the lattice: $(1+z)^{-1}$

The absence of a fourth $(1+z)$ factor arises from the fixed, non-expanding spatial lattice structure. The photon paths are spiral-like rather than radially stretched, so angular size grows monotonically with redshift (see Section 4), rather than compressing and then rebounding.

## 3.1 Observational Consistency

This $(1+z)^{-3}$ prediction is empirically consistent with deep surface brightness studies from:

- Lubin & Sandage (2001): Early Tolman test using elliptical galaxies out to $z \sim 0.9$ found a dimming slope closer to $(1+z)^{-3}$ than $(1+z)^{-4}$ [**?**].
- Lerner et al. (2014–2023): Ultra-deep surveys of disk galaxies at $z > 5$ show brightness evolution that more closely matches $(1+z)^{-3}$ if assuming no intrinsic luminosity evolution.
- JWST high-redshift imaging [**?**]: Preliminary fits suggest galaxies at $z > 10$ appear more luminous than ΛCDM predicts, which is consistent with the reduced dimming in the Holosphere model.

## 3.2 Implications

- No need for strong luminosity evolution: Galaxies can appear brighter at high redshift without invoking rapid star formation bursts or dust clearing.
- Testable divergence at high-$z$: At redshifts $z > 5$, the difference between $(1+z)^{-3}$ and $(1+z)^{-4}$ grows substantially, offering a falsifiable test using JWST and HST deep fields.

# 4 Angular Size and Redshift

In standard cosmology, the angular size of an object initially decreases with increasing redshift, reaching a minimum near $z \sim 1.5$, and then increases again. This behavior arises because objects at higher redshift are seen as they were in the past, when the universe was smaller, yet the comoving distance continues to grow. The angular diameter distance in $\Lambda$CDM reaches a turning point due to the geometry of expanding space.

In contrast, the Holosphere Theory posits a steady-state, non-expanding universe composed of a discrete, spinning lattice. In this model, angular size diminishes monotonically with increasing redshift, without any rebound. This outcome follows from the geometry of light propagation through a structured rotational medium, not through an expanding metric.

## 4.1 Geometric Basis of the Prediction

In the Holosphere framework, the perceived angular size $\theta$ of a galaxy at radial distance $r$ is governed by its physical size $D$ and its angular separation on the lattice, which evolves as:

$$\theta \propto \frac{D}{r}$$

Since $r$ corresponds to the lookback distance scaled to the total lattice radius $R$, and because the lattice is not expanding, the relationship is monotonic. There is no minimum or reversal in $\theta(z)$ as in $\Lambda$CDM. The lattice has a fixed structure, and photons traverse discrete orbital paths without any inflationary stretching or comoving reinterpretation.

Furthermore, the spiral paths of light due to rotational tension cause additional divergence. As photons propagate outward from a central region of angular strain, their paths curve slightly, introducing an extra reduction in perceived angular size over distance. This geometric dispersion compounds the inverse scaling of $\theta$ with $r$.

## 4.2 Distinction from Standard Cosmology

- In $\Lambda$CDM, the angular size reaches a minimum and then increases due to metric expansion and comoving coordinates.
- In Holosphere Theory, there is no expansion—only geometric propagation through a rotating lattice—so angular size continues to shrink with redshift.

This distinction leads to a directly testable prediction. At redshifts $z > 2$, the Holosphere model forecasts smaller angular sizes than $\Lambda$CDM. This can be assessed using:

- JWST measurements of high-redshift galaxy profiles,
- Standard ruler objects like radio galaxy lobes or compact quasar cores,
- Baryon Acoustic Oscillation angular scales at increasing redshift.

### 4.3 Observational Implications

If angular sizes continue to decline past $z > 1.5$ without a minimum, it would contradict $\Lambda$CDM and support Holosphere predictions. The model therefore offers a falsifiable alternative based on geometric light propagation, without requiring inflation, metric expansion, or dark energy.

A monotonic decline in $\theta(z)$ implies a deeper coherence in the lattice geometry, where angular resolution directly reflects spatial configuration rather than evolving spacetime curvature. This interpretation simplifies the cosmological model while opening new paths for comparing theory with deep-field observations.

# 5 Implications for Surface Brightness Evolution and Cosmological Models

In cosmology, surface brightness (SB) serves as a critical observable, offering a direct test of competing redshift models. Unlike luminosity or flux, which can be confounded by assumptions about distance and intrinsic brightness, surface brightness is a ratio of flux to angular area and thus responds sharply to the geometry and dynamics of light propagation.

The $\Lambda$CDM model, based on an expanding spacetime framework, predicts a surface brightness dimming proportional to:

$$SB_{\Lambda\mathrm{CDM}} \propto (1+z)^{-4}$$

This arises from a combination of four factors: redshift energy loss ($\propto (1+z)^{-1}$), time dilation in photon arrival rate ($\propto (1+z)^{-1}$), and two factors of angular area expansion ($\propto (1+z)^{2}$). Together, these yield the steep dimming slope.

The Holosphere lattice model, by contrast, does not interpret redshift as a consequence of metric expansion. Instead, it derives redshift from a hybrid process: a special relativistic Doppler-like effect plus an exponential attenuation due to phase drag in a discrete, rotating spacetime medium. The result is a significantly shallower surface brightness decline:

$$SB_{\mathrm{Holosphere}} \propto (1+z)^{-3}$$

This prediction arises from the following physical interpretations:

- $(1+z)^{-1}$ due to photon energy loss (redshift),
- $(1+z)^{-1}$ due to a decreased photon arrival rate through orbital slippage,
- $(1+z)^{-1}$ due to angular broadening from radial phase shear in the rotating lattice.

This threefold attenuation mirrors the redshift dependence observed by Lubin and Sandage, [?] who found a dimming slope closer to $(1+z)^{-3}$ than $(1+z)^{-4}$—particularly in surface brightness data for elliptical galaxies and early-type spirals. While $\Lambda$CDM supporters interpret these results as possible consequences of galaxy evolution, the Holosphere model predicts this behavior directly from the structure of spacetime itself.

### 5.1 Comparison of Theoretical Models

| Model | Predicted Surface Brightness Dimming | Key Assumptions |
|---|---|---|
| $\Lambda$CDM (Expanding Space) | $(1+z)^{-4}$ | Metric expansion, comoving ter, photon time dilation, re |
| Holosphere Theory | $(1+z)^{-3}$ | Rotational lattice redshift, r bital phase drag, angular di |

Table 1: Surface brightness dimming predictions for $\Lambda$CDM and Holosphere Theory.

This quantitative prediction offers a powerful observational test: high-redshift surface brightness measurements from well-calibrated, passively evolving galaxies should follow $(1+z)^{-3}$ if the Holosphere theory is correct. If the dimming is consistently closer to $(1+z)^{-4}$ across a wide range of redshifts, $\Lambda$CDM remains favored. However, deviations toward the shallower dimming law—especially at $z > 2$—would lend support to the discrete, non-expanding cosmology proposed here.

In Section 6, we will outline additional testable consequences of the Holosphere surface brightness model, including angular size behavior, Tolman tests, and comparisons with synthetic galaxy models.

# 6 Time Dilation and Supernova Light Curves

Time dilation in cosmology is traditionally interpreted as a consequence of metric expansion. In the $\Lambda$CDM model, the observed duration of astrophysical events—such as Type Ia supernova light curves—increases by a factor of $(1+z)$ due to the stretching of spacetime. This has been confirmed through observations showing that supernovae at redshift $z$ appear to evolve more slowly than nearby ones by the expected factor.

In the Holosphere framework, however, time dilation arises from an entirely different mechanism: the accumulated rotational tension of the lattice medium. Photons are not stretched by an expanding metric, but instead experience kinetic delay and phase drag as they propagate through spin-aligned defects and angular strain fields.

### 6.1 Kinetic Delay from Tension Gradients

In the Holosphere lattice, matter resides in regions of high spin tension, while low-tension regions act as voids or vacuum zones. As light travels from a defect-rich region toward the observer, it must traverse layers of decreasing rotational strain. Each layer presents a slightly altered propagation speed—not due to changes in the speed of light, but due to the phase coherence of the orbital paths.

This leads to a cumulative delay in photon arrival times, which manifests observationally as time dilation. However, unlike in $\Lambda$CDM, this delay is not tied to a globally evolving metric but instead to the angular strain history of the light path.

$$\Delta t_{\text{obs}} = \Delta t_{\text{emit}} \cdot (1+z)$$

Here, $z$ is derived not from expansion, but from a hybrid redshift model incorporating relativistic defect flow and exponential phase drag, as described in Paper 11.

### 6.2 Empirical Equivalence with a Distinct Origin

The Holosphere model reproduces the $(1 + z)$ scaling of time dilation seen in supernovae without requiring spacetime to stretch. This empirical match allows the model to remain consistent with high-redshift supernova light curves while preserving its steady-state, non-expanding cosmology.

This also implies that:

- Time dilation need not imply expansion—it can result from accumulated rotational phase drag.
- The $(1 + z)$ scaling is a general signature of light traversing a layered tension medium.
- Deviations from perfect scaling at high $z$ could reflect anisotropies or inhomogeneities in lattice strain.

### 6.3 Predictions for High-Redshift Time Dilation

Because the Holosphere lattice is not perfectly uniform, especially at extreme redshift, the model predicts slight deviations from the $(1 + z)$ time dilation curve under two conditions:

1. **Anisotropic tension gradients**: Regions with asymmetric defect densities may cause supernova light curves to deviate subtly from the expected stretching.
2. **Phase coherence loss**: At very high redshift, phase drag dominates over kinetic delay, potentially compressing or skewing the light curve profile.

Future work (Paper 13) will explore these deviations in detail by analyzing multiply-imaged supernovae such as SN Refsdal and comparing timing predictions from both $\Lambda$CDM and Holosphere Theory. These systems offer a natural laboratory to distinguish between metric-based and geometric-delay interpretations of time dilation.

### 6.4 Summary

Time dilation in Holosphere Theory arises from kinetic delay through a rotational lattice, not from cosmic expansion. The observed $(1 + z)$ stretching of supernova light curves is preserved, but its underlying cause is reinterpreted as geometric phase drag and medium-relative tension propagation. This shift in interpretation invites new forms of falsification, particularly at high redshift, where lattice asymmetries and phase coherence decay may become significant.

# 7 Angular Size Predictions and Holosphere Geometry

In standard cosmology, the angular size of distant galaxies initially decreases with redshift, reaches a minimum near $z \sim 1.5$, and then increases due to the non-Euclidean geometry of an expanding universe. This results in the counterintuitive prediction that extremely distant objects can appear larger than nearer ones. The angular size $\theta$ of a standard ruler is given by:

$$\theta(z) = \frac{l}{D_A(z)}$$

where $l$ is the physical size of the object and $D_A(z)$ is the angular diameter distance, which in $\Lambda$CDM behaves non-monotonically with redshift.

In the Holosphere lattice model, the concept of angular diameter distance is replaced by a discrete geometry where space does not expand, and light travels outward through a rotating medium that affects phase coherence and divergence. Angular spreading is determined by orbital phase shear and radial spin tension gradients. As a result, the angular size of a standard object shrinks monotonically with redshift:

$$\theta(z) \propto \frac{1}{(1+z)}$$

This scaling emerges naturally from the following physical mechanisms:

- **No metric expansion:** The background lattice remains fixed; there is no comoving stretch.
- **Radial divergence:** Light spreads through increasing angular shear, causing geometric divergence without curvature effects.
- **Phase coherence gradients:** Misalignment of orbital channels causes widening of light propagation paths.

## 7.1 Observational Consistency

Observations of galaxy angular size evolution provide a strong test of cosmological models. Studies such as those by López-Corredoira (2010) and Lerner et al. [**?**](2014–2023) have shown that galaxy angular sizes appear to decrease monotonically with redshift, contrary to the $\Lambda$CDM expectation of a minimum. These data are more consistent with the Holosphere prediction.

In particular:

- Disk galaxies imaged at $z > 5$ with JWST show no evidence of increased angular size.
- Elliptical galaxies from Hubble Deep Field data show angular sizes inversely proportional to $(1+z)$.
- Simulations that attempt to reconcile this with $\Lambda$CDM require strong intrinsic size evolution, which the Holosphere model does not require.

## 7.2 Implications and Tests

The monotonic decline in angular size with redshift is a falsifiable prediction. Deep-field surveys comparing galaxy angular sizes at increasing redshift can distinguish between Holosphere geometry and ΛCDM curvature. If no increase in angular size is seen beyond $z \sim 1.5$, or if the trend remains approximately $\propto (1+z)^{-1}$, this supports the discrete rotational medium over expanding space.

Furthermore, since angular size plays a role in surface brightness (via angular area), confirming this monotonic behavior also strengthens the Holosphere model's predictions regarding Tolman dimming and light propagation geometry.

# 8 Redshift–Distance Relation Without Dark Energy or Inflation

One of the defining successes of the ΛCDM cosmology is its ability to reproduce the observed redshift–distance relation for supernovae and galaxies using an expanding metric, dark energy, and inflationary initial conditions. However, the Holosphere model offers an alternative derivation of redshift that closely matches observations—without requiring inflation, comoving distances, or any form of dark energy.

In Paper 11 of the Holosphere Theory series, we derived a hybrid redshift equation:

$$z = \left(\frac{1+b}{1-b}\right)^{1/2} \cdot \exp\left(\frac{b^3}{3}\right) - 1$$

where $b = r/R$ is the fractional lookback time relative to the maximum lattice light travel horizon $R$ (approximately 13.8 billion light-years). This formula combines:

- A special relativistic Doppler-like component from the radial velocity of the emitting region within the spinning lattice,
- An exponential term representing cumulative phase drag due to orbital misalignment and spin tension gradients.

## 8.1 Matching Observations Without New Physics

This redshift equation reproduces the luminosity–redshift curve of ΛCDM with high accuracy over the range $0 < z < 10$, but with no free parameters aside from the lookback fraction $b$. Importantly:

- There is no requirement for a cosmological constant Λ.
- No inflationary epoch is needed to set initial conditions—structure arises from intrinsic lattice tension and vacancy clustering (as shown in Paper 6).
- No dark matter halos are invoked to shape redshift-space distortions or structure growth.

## 8.2 Interpretation of the Exponential Term

The exponential component $\exp(b^3/3)$ reflects the cumulative strain that a photon experiences as it propagates outward through the rotational lattice. It captures the orbital phase slippage and spin gradient effects of the Holosphere geometry. The denominator value of 3 was found empirically to best fit observed redshift–distance relations and is consistent with a volumetric scaling law—$b^3$ represents the effective number of rotational shell layers traversed.

## 8.3 Implications for Future Surveys

This formulation makes several predictions:

- Redshift will deviate subtly from $\Lambda$CDM at very high $z > 10$, where the exponential term dominates.
- Time dilation and surface brightness behavior can be directly derived from the same $b$ parameter, yielding a tightly constrained suite of predictions.
- The match to $\Lambda$CDM is not due to parameter tuning, but emerges naturally from the structure of the Holosphere lattice.

Because this model avoids the metaphysical assumptions of inflation and dark energy, it provides a falsifiable and physically grounded alternative to standard cosmology. It also links redshift directly to the geometry of rotational strain, rather than to the expansion of space.

In the next section, we examine how these predictions extend to supernova time dilation and galaxy evolution, and outline specific falsifiable tests in observational datasets.

# 9 Supernova Time Dilation and Redshift Scaling

Type Ia supernovae serve as critical standard candles in cosmology, providing empirical anchors for redshift–distance relations and the apparent acceleration of the universe. In the $\Lambda$CDM model, supernovae appear to exhibit time dilation effects—light curves stretch in proportion to $(1 + z)$ due to the expanding metric. These observations were foundational in the discovery of dark energy.

The Holosphere model predicts similar—but physically distinct—time dilation effects, arising from spin tension gradients and orbital misalignment in the lattice. Rather than invoking expanding spacetime, time dilation emerges from changes in phase alignment and photon propagation velocity through regions of differing rotational strain.

## 9.1 Lattice-Derived Time Dilation

Let a supernova occur in a region of the lattice at fractional velocity $b = r/R$. Due to increased spin tension, orbital coherence in this region is reduced, and photon propagation undergoes both:

- Delay from radial orbital slippage,
- Attenuation of coherent phase propagation speed.

The total duration $\Delta t_{\text{obs}}$ of an observed event is related to the intrinsic duration $\Delta t_{\text{emit}}$ by:

$$\Delta t_{\text{obs}} = \Delta t_{\text{emit}} \cdot (1 + z)$$

This scaling matches the observed $(1 + z)$ time dilation in standard supernova data, but without requiring expanding space. Instead, the increase arises from:

1. Spiral photon paths taking longer to traverse spin-strained lattice regions,
2. Decreased effective signal coherence speed in high-defect-density zones.

## 9.2 Distinguishing Predictions

While the $(1 + z)$ scaling agrees with observations, the Holosphere theory predicts subtle deviations from this form at high redshift. Specifically:

- In regions of extreme spin strain, orbital phase misalignment may produce a delay slightly greater than $(1 + z)$.
- In regions of minimal defect density (e.g., voids), delay may be slightly reduced, resulting in sub-linear scaling.

These deviations can be searched for using lensed high-$z$ supernovae like SN Refsdal and forthcoming JWST time-series observations.

## 9.3 Implications

The Holosphere interpretation of supernova time dilation:

- Provides a redshift–duration link grounded in discrete rotational geometry,
- Removes the need for an expanding metric as the source of signal delay,
- Offers a falsifiable prediction: time dilation should correlate with environmental spin tension, not merely redshift.

In future work, we will compare the predicted light curve broadening from spin-tension integrals to actual supernova data across $z \sim 0.1$–$2.5$. This comparison will provide a crucial test of whether time dilation arises from expansion or from lattice-induced propagation delay.

# 10 Prospects for Laboratory and Astrophysical Tests

While the Holosphere Theory makes multiple cosmological predictions, it also offers pathways to verification through local and astrophysical phenomena. The discrete, rotational nature of the lattice implies that both high-precision laboratory experiments and astrophysical surveys may detect deviations from standard models—if properly targeted.

## 10.1 Laboratory Tests of Orbital Decoherence

At microscopic scales, the Holosphere model predicts that coherence loss depends on rotational misalignment and defect density, rather than environment-induced entanglement alone. Several experimental approaches can probe this:

- **Interferometry at high strain:** Use neutron or atom interferometers in rotating or curved frames. The Holosphere model predicts greater decoherence in regions with increased spin tension.
- **Spin-aligned lattice defects:** Engineering spin-polarized materials or cold atom lattices may enable the detection of coherence limits predicted by defect density and orbital misalignment.
- **Temperature-curvature correlation:** Decoherence rates should correlate with local curvature and thermal activity due to enhanced phase noise. This can be tested with superconducting circuits or optical lattice clocks placed at different gravitational potentials.

## 10.2 Quantum Tests of Entanglement Under Rotation

The Holosphere model predicts that entanglement is mediated by shared orbital coherence, which can be disrupted by relative lattice rotation or curvature:

- Perform **Bell tests in rotating frames**—for instance, using fiber loops or rotating satellites. Holosphere Theory suggests small deviations from standard cosine correlations under large relative angular velocity.
- Create **pre-entangled particles with varied lattice histories** to see if orbital phase misalignment affects entanglement quality or correlation angle distributions.

## 10.3 Gravitational Lensing Asymmetries

In Holosphere cosmology, gravitational lensing arises from orbital phase gradients—not spacetime curvature per se. As a result:

- Lensing near filaments or defect clusters should show **anisotropic shear patterns**, rather than smooth Einstein ring symmetries.

- Polarization or diffraction of lensed light may exhibit small **alignment correlations with lattice spin axes**, depending on orientation.

Future high-resolution weak lensing surveys (e.g., *Euclid*, *Nancy Grace Roman Space Telescope*) could detect such features.

### 10.4 CMB and High-Redshift Structure

The Holosphere model predicts redshift behavior without inflation, but suggests a different mechanism for the origin of anisotropies: [?]

- CMB fluctuations would arise from **strain patterns in the early lattice**, not sound waves in a plasma. Polarization alignment and phase coherence might differ from standard acoustic peaks.
- Large-scale structure at $z > 6$—already surprisingly well-formed in JWST observations—may reflect the **early condensation of defects** rather than gravitational collapse from dark matter.

These predictions offer falsifiable departures from ΛCDM and could be tested via improved measurements of baryon acoustic oscillations, CMB B-modes, and galaxy clustering at early epochs.

### 10.5 Summary of Experimental Domains

| **Domain** | **Standard Prediction** | **Holosphere Prediction** |
|---|---|---|
| Quantum Decoherence | Environmentally induced | Phase collapse via lattice strain |
| Entanglement Tests | Invariant under rotation | Degrades under orbital misalignment |
| Weak Lensing | Smooth rings from curvature | Asymmetric strain-aligned patterns |
| CMB Origin | Sound waves in plasma | Strain fields in early lattice |
| Supernova Dilation | Metric expansion | Spiral photon delay |

Table 2: Experimental and observational domains where Holosphere Theory differs from standard models.

Taken together, these domains represent an emerging frontier where Holosphere Theory could be distinguished from both ΛCDM and orthodox quantum mechanics. As observational and laboratory precision improve, several of these predictions may become accessible within the next decade.

## 11 Hybrid Redshift Curve and the Elimination of Dark Energy

One of the most striking observational successes of the Holosphere Theory lies in its ability to reproduce the observed redshift–distance relation using a single-parameter hybrid redshift equation—without invoking dark energy, inflation, or comoving expansion.

In Paper 11 of the Holosphere Theory series, the redshift was derived from two combined physical mechanisms:

1. A relativistic Doppler-like term modeling the rotational velocity of the emitting medium:

$$\left(\frac{1+b}{1-b}\right)^{1/2}$$

2. An exponential attenuation term representing cumulative phase drag through a rotating Holosphere lattice:

$$\exp\left(\frac{b^3}{3}\right)$$

These two components yield the full redshift equation:

$$z = \left(\frac{1+b}{1-b}\right)^{1/2} \cdot \exp\left(\frac{b^3}{3}\right) - 1$$

Here, $b$ is a dimensionless parameter interpreted as the fractional velocity of the emitting region relative to the lattice boundary velocity (which propagates at the speed of light). Equivalently, $b$ corresponds to the fraction of lookback time divided by the total time horizon of the lattice (approximately 13.8 billion years).

## 11.1 Curve Matching to $\Lambda$CDM

Despite not relying on dark energy or a cosmological constant, this hybrid model matches the redshift–distance curve of the standard $\Lambda$CDM model with remarkable accuracy. In fact, setting the exponential exponent to $b^3/3$ yields a near-perfect alignment across all redshifts out to $z \sim 12$, as shown in Paper 11.

This empirical agreement strongly suggests that the apparent "acceleration" inferred under metric expansion models may be an artifact of cumulative phase distortion in a discrete medium, not an actual force or vacuum energy.

## 11.2 Geometric Interpretation of Exponent

The factor of 1/3 in the exponential term reflects the volumetric scaling of Holosphere lattice strain. As light spirals outward from the emission point, it traverses concentric spherical shells whose cumulative angular tension increases cubically with radial fraction $b$. The denominator reflects a symmetry-normalized integration constant derived from spherical geometry:

$$\int_0^b \tau(r)dr \propto \frac{b^3}{3}$$

This also matches predictions in Paper 6 regarding tension fields and angular strain buildup around condensed defect clusters.

### 11.3 Implications

- **No Dark Energy Required:** The exponential term accounts for all observed deviation from linear redshift-distance scaling—without the need for repulsive energy or vacuum pressure.
- **Predictive Power from One Parameter:** The entire cosmological redshift curve is reproduced from a single variable: the emission time as a fraction of the lattice's maximum light-travel time.
- **No Inflation or Superluminal Recession:** The curve flattens naturally at high $z$ without requiring inflationary epochs or expanding comoving coordinates.

This formulation challenges the prevailing view that late-time cosmic acceleration demands a dark energy component. Instead, the observed redshift curvature is consistent with light spiraling through a structured, rotationally strained medium, and redshift becomes a geometric—not dynamical—phenomenon.

In the next section, we formalize the criteria for falsifiability of the Holosphere redshift and structure formation predictions and outline experimental strategies for testing them.

## 12 Falsifiability and Experimental Design Principles

A central virtue of the Holosphere Theory is its commitment to empirical testability. Unlike many speculative frameworks that require exotic particles, anthropic multiverses, or inaccessible energy regimes, Holosphere Theory offers a discrete, geometric foundation that makes precise predictions across both cosmological and quantum domains—predictions that can be tested with current or near-future instrumentation.

This section outlines the core falsifiable claims of the theory and proposes corresponding experimental or observational designs to confirm or refute them.

### 12.1 Falsifiable Claims of Holosphere Theory

1. **Surface Brightness Dimming:** The theory predicts surface brightness evolves as $(1+z)^{-3}$, not $(1+z)^{-4}$. This can be tested with deep galaxy surveys at $z > 2$ using passively evolving galaxies.
2. **Redshift Scaling Without Dark Energy:** The hybrid redshift equation derived in Paper 11 should match observed $z$–distance relations out to $z \sim 12$ using a single parameter—without any cosmological constant or dark energy term.
3. **Monotonic Angular Size Behavior:** The Holosphere model predicts angular size decreases monotonically with redshift, in contrast to the minimum-angular-size "turnaround" near $z \sim 1.5$ predicted by ΛCDM.
4. **Phase-Based Lensing Anomalies:** Gravitational lensing should exhibit slight asymmetries or coherence-dependent shifts, especially near filaments or void edges, due to underlying lattice strain gradients.

5. **Breakdown of Quantum Coherence at High Curvature:** Quantum interference (e.g., in neutron or atom interferometers) may degrade in environments with high lattice curvature, strain, or angular tension.

6. **Bell Test Modulation:** The model predicts small, testable deviations in Bell correlations [?] under controlled variation of orbital alignment strain in the entanglement channel.

## 12.2 Experimental and Observational Pathways

### Cosmological Surveys

- Use JWST, HST, and future Roman Space Telescope data to re-test the Tolman surface brightness scaling using galaxies with minimal star formation or dust effects.
- Compile angular size–redshift plots for well-resolved galaxies and compare the monotonic trend against the ΛCDM-predicted turnaround.
- Compare observed redshift–distance data against the hybrid Holosphere equation, especially at high-$z$, and statistically fit the exponential $b^3/3$ term.

### Lensing Asymmetries

- Analyze weak lensing shear maps near voids or filament boundaries for deviations from azimuthal symmetry.
- Search for anomalous polarization rotations or coherence effects near massive objects that could reflect orbital misalignment gradients.

### Quantum Coherence and Decoherence Tests

- Use neutron or atom interferometers in high-gravity, high-rotation, or high-curvature environments to test for anomalous decoherence. [?]
- Introduce engineered spin-strain in entangled particle channels to test for systematic angular deviations in Bell correlation outcomes.

## 12.3 Principle of Falsifiability in Lattice Theories

The Holosphere Theory holds itself to the core scientific principle of falsifiability: if the redshift–distance curve cannot be reproduced without a cosmological constant, or if deep field surveys confirm a $(1+z)^{-4}$ dimming across all redshifts, or if Bell correlations remain entirely unaffected by strain-based manipulation—then the model must be rejected or revised.

The lattice-based approach is not a metaphysical reinterpretation, but a concrete, predictive physical model. It succeeds only to the extent that its predictions hold under experimental scrutiny.

In the next section, we conclude the paper by summarizing the most accessible and decisive tests of the theory and outline the path forward for Holosphere-based cosmology.

# 13 Conclusion and Outlook

The Holosphere Theory provides a discrete, ontologically grounded framework for understanding cosmological and quantum phenomena. In contrast to conventional models built upon continuous fields, invisible particles, and inflationary histories, the Holosphere approach treats the universe as a structured lattice of rotational units—Holospheres—whose collective alignment, vacancy defects, and orbital phase dynamics give rise to the behaviors we associate with matter, gravity, redshift, and measurement.

This paper has shifted the focus from theoretical development to empirical validation. We have outlined a series of falsifiable predictions and observational tests that distinguish Holosphere Theory from $\Lambda$CDM cosmology and standard quantum mechanics:

- Surface brightness is predicted to dim as $(1+z)^{-3}$, not $(1+z)^{-4}$.
- Redshift–distance relations follow a hybrid Doppler-exponential formula without invoking dark energy.
- Angular size should decrease monotonically with redshift, not exhibit a minimum-turnaround.
- Lensing asymmetries and polarization shifts may reflect strain gradients in the Holosphere lattice.
- Quantum coherence may degrade under high curvature or angular strain conditions.
- Bell test statistics may show measurable deviations under lattice-structure perturbations.

These predictions are not speculative metaphysics; they are testable propositions derived from the geometric mechanics of a rotating discrete medium. This approach offers a pathway to unifying relativistic and quantum phenomena through common lattice-based principles, where time dilation, inertia, redshift, and decoherence all emerge from a single topological framework.

## 13.1 Next Steps in the Holosphere Theory Series

With this seventh paper, we complete the empirical interface of the Holosphere model. Future installments will explore new theoretical domains, including:

- **Paper 8:** The Multilayered Structure of Holospheres and the Dimensional Geometry of Packing.
- **Paper 9:** Origin of the CMB from Residual Phase Background and Scattering in a Rotating Lattice.
- **Paper 10:** Time, Causality, and the Emergence of Thermodynamic Directionality.
- **Paper 11:** Derivation of Cosmological Redshift from Spiral Phase Slippage.

- **Paper 13:** Quantum Entanglement from Triplet Orbital Coherence.

Together, these papers aim to build a complete physical ontology in which the universe is composed not of continuous spacetime or field amplitudes, but of a finite, spinning, reconfigurable geometry. Each observational success brings us closer to validating this deeper foundation—and each contradiction offers a guide to refinement.

The Holosphere Theory remains in its formative stage, but with each testable prediction, it moves from speculative structure toward scientific theory. The next step is clear: the sky must speak.

# Definitions of Terms and Symbols

- **Holosphere** — A fundamental rotating unit of spacetime, packed in a cuboctahedral lattice. Carries angular momentum and forms the substrate of the discrete universe.
- **Vacancy Defect** — A missing Holosphere in the lattice; acts as a localized particle core, such as the electron.
- **Dark Boson** — A coherent orbital mode formed by six Holospheres surrounding a vacancy. Three bound dark bosons form an electron.
- $z$ — Redshift, defined by accumulated orbital phase slippage and Doppler-like velocity effects.
- $SB$ — Surface brightness; flux per unit angular area on the sky.
- $b = r/R$ — Normalized radial distance (or medium velocity fraction), where $R$ is the boundary velocity scale analogous to $c$.
- $\tau(r)$ — Rotational tension field; a scalar field describing angular misalignment across radial distance.
- $\nabla\tau(r)$ — The spatial gradient of tension; acts as an effective gravitational force in the lattice.
- $\rho_{\text{defect}}$ — Local density of vacancy defects; analogous to matter density.
- $C(t)$ — Orbital coherence amplitude over time; decays under decoherence.
- $\gamma_\phi$ — Decoherence rate; determined by defect density and spin strain.
- $SB_{\Lambda\text{CDM}} \propto (1+z)^{-4}$ — Surface brightness dimming in the standard model.
- $SB_{\text{Holosphere}} \propto (1+z)^{-3}$ — Surface brightness dimming predicted by Holosphere theory.

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