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Cosmology in NUVO Theory: Redshift, Expansion, and Structure Formation without Curved Spacetime - Part 8 of the NUVO Theory Series

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Cosmology in NUVO Theory: Redshift, Expansion, and Structure Formation Without Curved Spacetime - Part 8 of the NUVO Theory Series

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Abstract: This paper applies NUVO theory to cosmology, demonstrating how a flat-space scalar conformal field $\lambda(t, r, v)$ can account for key cosmological observations typically attributed to spacetime curvature. We derive the redshift–distance relation, expansion rate history, and scalar-driven structure formation in a purely conformal background, offering an alternative to standard FLRW-based models without invoking dark energy or inflation.

Keywords: NUVO theory; conformal scalar field; scalar field dynamics; energy–momentum tensor; time-dilation; relativistic correspondence; Newtonian mechanics; conformal coupling; pinertia; sinertia; Cosmology; Redshift; Cosmic Expansion

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1. Introduction

Modern cosmology, grounded in general relativity, interprets large-scale observations through the lens of curved spacetime. The Friedmann–Lemaître–Robertson–Walker (FLRW) metric describes an expanding, isotropic universe, driven by energy–momentum components such as radiation, matter, and a cosmological constant. While successful in explaining many observations, the FLRW framework carries unresolved challenges: the cosmological constant problem, the unexplained onset of inflation, the Hubble tension, and the need for dark matter to initiate structure formation.

NUVO theory offers a fundamentally different starting point. Rather than assuming curvature in the fabric of spacetime, NUVO operates on a globally flat manifold, where gravitational and inertial effects emerge from a scalar conformal field $\lambda(t, r, v)$ [1]. This scalar field modulates both time and spatial intervals locally, encoding relativistic and gravitational behavior without invoking the Einstein field equations or geometric curvature.

The goal of this paper is to demonstrate how the NUVO scalar field naturally generates cosmological effects typically attributed to curvature and exotic energy components. Specifically, we show that:

- Redshift arises from scalar time modulation, not Doppler recession or metric expansion.
- Cosmic expansion history can be derived from the time evolution of $\lambda(t)$.
- Structure formation can emerge from scalar field fluctuations without requiring cold dark matter.
- The apparent acceleration of the universe is a natural outcome of conformal evolution in $\lambda(t)$.

This conformal scalar approach preserves flatness, introduces no exotic fields or ad hoc inflation mechanisms, and enables a continuous bridge from local gravitational dynamics to cosmic-scale modulation. In the following sections, we develop the scalar-based analogs of redshift, expansion rate, cosmological distance measures, and large-scale structure evolution. We also compare this framework with ΛCDM, highlight observational consequences, and propose paths for future cosmological simulations grounded in NUVO's geometric principles.

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2. Conformal Time Modulation and Redshift

In NUVO theory, redshift is not interpreted as a Doppler shift caused by metric expansion or recession velocity. Instead, it arises from the conformal modulation of local time intervals by the scalar field $\lambda(t, r, v)$. In a cosmological context, we consider the velocity-independent, large-scale homogeneous component $\lambda(t)$ to dominate, leading to scalar-driven temporal evolution across the universe.

2.1. Temporal Modulation in $\lambda(t)$ and Scale Factor Analogy

In the standard FLRW cosmology, redshift is encoded in the time-dependent scale factor $a(t)$ via:

$$1 + z = \frac{a(t_{\text{obs}})}{a(t_{\text{emit}})}$$

In NUVO, proper time experienced by atomic clocks is scaled by the conformal field:

$$d\tau = \frac{dt}{\lambda(t)} \tag{1}$$

This leads to an analogous redshift definition based on the relative modulation of time intervals between emission and observation:

$$1 + z = \frac{\lambda(t_{\text{obs}})}{\lambda(t_{\text{emit}})} \tag{2}$$

This relation shows that as $\lambda(t)$ increases over cosmological time, light emitted in the past (when λ was smaller) will appear redshifted due to the geometric stretching of temporal intervals.

2.2. Derivation of the Redshift Relation

Let a photon be emitted at cosmic time t_{emit} with intrinsic frequency ν_{emit} and received at t_{obs} with observed frequency ν_{obs}. Since in NUVO the proper time between photon wavefronts is modulated by $\lambda(t)$, we have:

$$\nu_{\text{emit}} = \frac{1}{\Delta\tau_{\text{emit}}} = \frac{\lambda(t_{\text{emit}})}{\Delta t}, \quad \nu_{\text{obs}} = \frac{1}{\Delta\tau_{\text{obs}}} = \frac{\lambda(t_{\text{obs}})}{\Delta t}$$

Taking the ratio gives:

$$\frac{\nu_{\text{obs}}}{\nu_{\text{emit}}} = \frac{\lambda(t_{\text{obs}})}{\lambda(t_{\text{emit}})} \quad \Rightarrow \quad 1 + z = \frac{\lambda(t_{\text{obs}})}{\lambda(t_{\text{emit}})} \tag{3}$$

Thus, the redshift is fully determined by the evolution of the scalar field $\lambda(t)$, with no need to invoke velocity or spatial expansion. This distinguishes NUVO from both Doppler-based and FLRW-based redshift interpretations.

2.3. Comparison with Cosmological Redshift in FLRW

The key difference between NUVO and FLRW is that NUVO preserves a globally flat, non-expanding spatial manifold. Light rays traverse this flat space, but time intervals and frequency relationships are modulated by a scalar field. The observational result—spectral redshift—is identical in form [2]:

$$1 + z = \text{ratio of 'clock rates'} = \frac{\text{modulation at reception}}{\text{modulation at emission}}$$

In FLRW:

$$1 + z = \frac{a(t_{\text{obs}})}{a(t_{\text{emit}})} \quad \text{(expanding metric)}$$

In NUVO:

$$1 + z = \frac{\lambda(t_{\text{obs}})}{\lambda(t_{\text{emit}})} \quad \text{(modulated time geometry)}$$

Therefore, observational predictions such as Hubble plots, redshift drift, and distance–redshift relations remain accessible in NUVO, but emerge from fundamentally different geometric mechanisms.

This lays the foundation for constructing a scalar-based expansion history, to which we now turn.

3. Expansion History from Scalar Field Dynamics

With the redshift relation in NUVO theory derived from the time dependence of the scalar field $\lambda(t)$, we can construct an effective expansion history analogous to the Hubble parameter $H(z)$ in standard cosmology. However, rather than deriving this from metric expansion, we extract it directly from the rate of temporal modulation.

3.1. Time-Evolution of $\lambda(t)$ and Effective Hubble Function $H(z)$

Define the NUVO Hubble-like function as the logarithmic rate of change of the scalar field:

$$H_\lambda(t) \equiv \frac{d}{dt} \ln \lambda(t) = \frac{\dot{\lambda}(t)}{\lambda(t)} \tag{4}$$

This quantity governs the apparent rate of redshift accumulation and corresponds observationally to the inferred Hubble parameter when interpreted through NUVO's conformal time model.

Using the NUVO redshift relation,

$$1 + z = \frac{\lambda(t_0)}{\lambda(t)}$$

we may express this as a function of redshift:

$$H_\lambda(z) = -\frac{1}{\lambda}\frac{d\lambda}{dz}\frac{dz}{dt} = \frac{d}{dt} \ln \lambda(z) \tag{5}$$

Once a model or empirical fit for $\lambda(t)$ or $\lambda(z)$ is specified, the full expansion history $H(z)$ can be reconstructed.

3.2. Correspondence with Standard Eras: Radiation, Matter, and Late Acceleration

By analogy with the FLRW solution to the Friedmann equations, we can associate distinct regimes of $\lambda(t)$ with physical eras [3] [4]:

- **Radiation era:** Suppose $\lambda(t) \propto t^{1/2}$, then $H_\lambda(t) \propto 1/(2t)$, mimicking standard radiation-dominated behavior.
- **Matter era:** For $\lambda(t) \propto t^{2/3}$, we obtain $H_\lambda(t) \propto 2/(3t)$, consistent with matter domination.
- **Late-time acceleration:** If $\lambda(t) \propto e^{Ht}$ at late times, then H_λ becomes approximately constant, matching an effective cosmological constant.

Thus, without changing the flatness of space, the scalar field $\lambda(t)$ can reproduce key phenomenological epochs of expansion, each characterized by different time-scaling behavior.

3.3. Constraints from Supernovae and CMB Observables

Supernovae Ia luminosity distances, baryon acoustic oscillation (BAO) scales, and cosmic microwave background (CMB) angular sizes are all sensitive to the integral history of expansion [5]:

$$d_L(z) = (1+z) \int_0^z \frac{dz'}{H(z')}$$

In NUVO, this becomes:

$$d_L(z) = (1+z) \int_0^z \frac{dz'}{H_\lambda(z')} = (1+z) \int_0^z \frac{1}{\frac{d}{dt} \ln \lambda(z')} dz' \tag{6}$$

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Therefore, by fitting $\lambda(z)$ to match observational data, NUVO can produce curves consistent with ΛCDM predictions—without invoking dark energy or curved spacetime. This provides a scalar, geometric explanation for the apparent acceleration of cosmic expansion observed in supernovae and CMB datasets.

3.4. Summary

NUVO replaces the scale factor $a(t)$ with the scalar modulation function $\lambda(t)$, whose evolution generates redshift and governs apparent cosmic acceleration. The effective Hubble function $H_\lambda(t)$ directly reflects this scalar evolution, allowing observational concordance with the radiation, matter, and dark energy eras—within a purely flat, conformally modulated geometry.

4. Distance Measures in a Flat Modulated Geometry

In standard cosmology, distance measures such as proper distance, comoving distance, luminosity distance, and angular diameter distance are derived from the FLRW metric and depend on the scale factor $a(t)$. In NUVO theory, the universe is not expanding spatially, but rather evolving temporally through the scalar field $\lambda(t)$. Nevertheless, observational distance relations remain well-defined and can be computed through modulation-based analogs.

4.1. Proper Distance and Luminosity Distance Under λ Modulation

In NUVO, spatial distances remain Euclidean. The proper (coordinate) distance r between two events is given simply by:

$$d_{\text{prop}} = r \tag{7}$$

However, light travel time and energy flux are modulated by $\lambda(t)$, affecting perceived brightness and redshift. The luminosity distance is defined analogously to FLRW, with redshift arising from $\lambda(t)$:

$$d_L(z) = (1+z)\, r(z) = \frac{\lambda(t_0)}{\lambda(t)} \cdot r(z) \tag{8}$$

Using the NUVO Hubble function $H_\lambda(z)$:

$$r(z) = \int_0^z \frac{dz'}{H_\lambda(z')} \tag{9}$$

we recover the full luminosity distance:

$$d_L(z) = (1+z) \int_0^z \frac{dz'}{H_\lambda(z')} \tag{10}$$

This mirrors FLRW's structure but arises from scalar field modulation, not spatial curvature or expansion.

4.2. Comparison with Comoving Distance in FLRW

In FLRW, the comoving distance r_{com} is defined via the scale factor and used to calculate the horizon size and causally connected regions:

$$r_{\text{com}} = \int_{t_{\text{emit}}}^{t_0} \frac{dt'}{a(t')}$$

In NUVO, the analogous expression is based on the unmodulated flat space and coordinate time. Since light travels at c in flat space, the comoving (coordinate) distance for a photon emitted at t_{emit} is:

$$r_{\text{com}} = \int_{t_{\text{emit}}}^{t_0} \frac{dt'}{\lambda(t')} \tag{11}$$

Here, the $\lambda(t')$ factor comes from the time-scaling of light cycles, replacing the $a(t)$ factor in FLRW cosmology.

4.3. Angular Diameter Distance and Implications for BAO Observations

The angular diameter distance in NUVO follows from the standard relation:

$$d_A(z) = \frac{r(z)}{1+z} \tag{12}$$

where $r(z)$ is again the radial coordinate distance in flat space.

This relation leads to a consistent prediction for features such as:

- Baryon Acoustic Oscillation (BAO) angular scales,
- CMB acoustic peaks,
- Redshift-dependent angular size of standard rulers.

Because the form of $d_A(z)$ and $d_L(z)$ in NUVO mirrors those of FLRW, observational consistency is retained — with the critical distinction that all distance and redshift behavior is driven by scalar modulation, not metric expansion.

4.4. Summary

NUVO reproduces cosmological distance relations by mapping scale-factor-based measures to scalar-field-driven modulation effects. Proper distance remains flat and Euclidean, while apparent distances (e.g., luminosity and angular diameter) are shaped by the evolution of $\lambda(t)$, enabling agreement with observational data without invoking spatial curvature or expansion.

5. Structure Formation via Scalar Field Perturbations

One of the core challenges in standard cosmology is explaining how initial fluctuations grew into the large-scale structure observed today. In ΛCDM, cold dark matter is invoked to generate gravitational wells that amplify baryonic overdensities. NUVO theory offers an alternative: scalar fluctuations in $\lambda(t,r)$ generate effective variations in proper time and force gradients, enabling structure formation without requiring dark matter.

5.1. Scalar Wave Fluctuations as Seeds of Structure

In NUVO, the global evolution of $\lambda(t)$ governs redshift and cosmic acceleration, while local deviations in $\lambda(t,r)$ encode density variations. Let us decompose the field into a homogeneous background and small fluctuations:

$$\lambda(t,r) = \bar{\lambda}(t) + \delta\lambda(t,r) \tag{13}$$

The wave equation for $\lambda(t,r)$ derived earlier (see Part 3 of this series) is:

$$\Box\lambda = \frac{1}{\kappa}\rho(x^\mu) \tag{14}$$

In linear perturbation theory, the scalar fluctuations satisfy:

$$\Box\delta\lambda = \frac{1}{\kappa}\delta\rho \tag{15}$$

These scalar waves propagate in flat space and can accumulate coherently over time, leading to modulated regions with slightly different time evolution and hence matter dynamics.

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5.2. *Growth of Overdensities and Matter Clustering*

Regions with $\delta\lambda > 0$ experience slower proper-time evolution (since $d\tau = dt/\lambda$), effectively delaying local dynamical processes. Conversely, regions with $\delta\lambda < 0$ evolve more rapidly and appear to attract surrounding matter.

The net result is a modulation-induced force imbalance:

$$\nabla\lambda \neq 0 \quad \Rightarrow \quad \nabla(\text{local time rate}) \quad \Rightarrow \quad \text{directional acceleration of mass flow}$$

This leads to a self-reinforcing mechanism: - Slight overdensities correspond to lower λ (faster local clocks), - Matter flows toward these regions due to modulation-induced gradients, - This enhances $\delta\lambda$ further, leading to clustering.

Thus, structure formation proceeds without cold dark matter, driven instead by coherent scalar dynamics and feedback through $\lambda(t, r)$.

5.3. *No Need for Dark Matter: Modulation-Induced Attraction and Coherence*

Standard cosmology requires dark matter to seed structure prior to recombination, due to the photon–baryon coupling suppressing ordinary matter collapse. NUVO bypasses this by modulating time evolution directly — fluctuations in λ affect dynamical evolution independently of the thermal state of the plasma.

Advantages of this approach:

- No need to invoke non-baryonic matter or additional particle species.
- Coherence emerges naturally from the scalar wave equation.
- Gravitational potential wells arise from geometry modulation, not from invisible mass.

This opens a novel path toward modeling structure formation using scalar field simulations in flat space, with proper relativistic time behavior encoded in λ.

5.4. *Summary*

In NUVO, scalar perturbations in $\lambda(t, r)$ replace cold dark matter as the driver of cosmic structure. Fluctuations grow via modulation-induced temporal asymmetries that act as effective gravitational wells. This produces clustering, matter flows, and early seed coherence — all within a flat, conformally modulated spacetime and without invoking any additional matter content beyond baryons.

6. Cosmic Horizon, Entropy, and Inflation Alternatives

Standard cosmology invokes inflation to address several puzzles of the early universe: the horizon problem, flatness problem, and entropy growth. In NUVO theory, these issues are naturally resolved or recast through the dynamics of the scalar field $\lambda(t)$, which defines causal structure and thermodynamic behavior in a flat spacetime without requiring exponential expansion.

6.1. *Causal Structure and Horizon Scale Under $\lambda(t)$*

In FLRW cosmology, the finite speed of light and finite age of the universe limit the observable horizon. This leads to the horizon problem: regions of the CMB sky appear causally disconnected yet exhibit thermal uniformity. Inflation solves this by proposing rapid early expansion.

In NUVO, the concept of a particle horizon still applies, but is determined by the integration of λ-modulated time:

$$r_{\text{horizon}}(t) = \int_0^t \frac{dt'}{\lambda(t')} \tag{16}$$

A sufficiently small $\lambda(t')$ in the early universe elongates this causal horizon, allowing distant regions to have been in communication even without inflation. That is, **temporal modulation via low initial λ mimics the causal reach of inflationary expansion**, while preserving flat spatial geometry.

6.2. Entropy Growth and Arrow of Time in NUVO

Entropy in NUVO theory is governed not just by matter and radiation distributions, but also by the scalar modulation of time. As $\lambda(t)$ increases, proper time advances more slowly relative to coordinate time:

$$d\tau = \frac{dt}{\lambda(t)} \quad \Rightarrow \quad \text{entropy production per unit } \tau \text{ diminishes}$$

This leads to a geometric arrow of time: the direction in which $\lambda(t)$ increases defines a preferred temporal orientation in both matter evolution and thermodynamic behavior.

Additionally, sinertia—the geometric response of space to matter—can collapse or concentrate during early scalar wave resonances, releasing geometric energy and further increasing entropy via conformal modulation.

6.3. Modulated Initial Conditions as Alternative to Inflation

Inflation provides homogeneity and flatness by smoothing initial conditions over a rapidly inflating patch. NUVO offers a different solution: - Begin with a globally flat space and scalar field $\lambda(t,r)$, - Impose modulated initial conditions that include coherent oscillations or standing wave structure, - Allow scalar evolution and early field collapse (e.g., sinertia) to generate initial thermal and spatial uniformity.

This bypasses the need for a separate inflationary mechanism and removes reliance on a hypothetical inflaton field. Coherence and large-scale structure arise directly from scalar modulation, governed by field equations in flat space.

6.4. Summary

NUVO replaces inflation with scalar modulation as the source of early causal connectivity and structure coherence. A small initial $\lambda(t)$ elongates the causal horizon, entropy grows via sinertia collapse and temporal modulation, and geometric standing waves offer a natural path to homogeneity. These effects replicate the key successes of inflation without curved spacetime, quantum inflaton fields, or exponential expansion.

7. Discussion and Observational Signatures

NUVO cosmology reproduces the observational successes of standard ΛCDM — including redshift, distance measures, structure growth, and late-time acceleration — using an entirely different mechanism: scalar modulation in a globally flat geometry. This shift in explanatory framework leads to unique observational consequences that distinguish NUVO from curved-spacetime models.

Key Differences with ΛCDM

Several conceptual and physical differences separate NUVO from standard cosmology:

- **Flat background:** NUVO uses a non-expanding, flat spatial manifold, with all evolution encoded in $\lambda(t)$.
- **No dark energy:** Apparent acceleration arises from scalar modulation, not a cosmological constant.
- **No cold dark matter:** Structure formation is driven by scalar field perturbations, not invisible mass.
- **No inflation:** Early coherence and causal connectivity result from low $\lambda(t)$ and scalar wave structure.

Despite these foundational changes, NUVO yields equivalent predictions for many observables — while eliminating the need for multiple hypothetical energy components.

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Potential to Resolve the Hubble Tension via Dynamic $\lambda(t)$

The Hubble tension refers to the persistent discrepancy between the locally inferred value of H_0 from supernovae and Cepheid data, and the value inferred from early-universe physics (CMB + ΛCDM).

In NUVO, the Hubble-like function is derived from:

$$H_\lambda(t) = \frac{\dot{\lambda}(t)}{\lambda(t)}$$

Because this arises from scalar field evolution — not the derivative of a spatial scale factor — it is not constrained by the same early-universe assumptions that govern FLRW models. This allows NUVO to support a time-varying $H_\lambda(z)$ profile that accommodates both early and late measurements without tension, potentially resolving the discrepancy naturally through conformal evolution.

Signatures in CMB, Lensing, and Large-Scale Structure Surveys

While many NUVO predictions overlap with standard cosmology, key signatures may emerge in high-precision observations:

- **CMB anisotropy:** The imprint of scalar field modulation (rather than spatial curvature) may affect the detailed shape of acoustic peaks or phase shifts in polarization spectra.
- **Gravitational lensing:** Lensing may exhibit small deviations due to the absence of metric curvature — replaced by scalar-modulated null geodesics.
- **Redshift drift and BAO:** The evolution of $H_\lambda(z)$ could be extracted directly from BAO and redshift drift surveys (e.g., ELT, SKA) to distinguish between NUVO and FLRW expansion.

Each of these offers a testable pathway to compare NUVO's scalar modulation framework with metric-based cosmology.

7.1. Interpretation

NUVO recasts cosmological expansion as modulation of proper time, with flat geometry and scalar field dynamics accounting for all large-scale observations. This reduces theoretical complexity by eliminating the need for dark energy, inflation, and unseen matter — replacing them with a single, dynamic geometric field $\lambda(t, r)$ whose structure unifies both local and cosmological phenomena.

7.2. Summary

The observational predictions of NUVO cosmology align with those of ΛCDM across a broad spectrum of measurements. However, the underlying mechanisms differ substantially. NUVO offers a simplified, flat-space framework in which scalar modulation drives redshift, expansion, structure, and thermal history — leading to new avenues for observational testing in upcoming cosmological surveys.

8. Outlook and Future Work

This paper has presented a scalar-based cosmological framework grounded in NUVO theory, in which the evolution of the universe is driven not by spatial curvature or metric expansion, but by temporal modulation of a scalar conformal field $\lambda(t, r, v)$. By treating gravitational and inertial effects as manifestations of scalar modulation on a flat background, NUVO reproduces core cosmological phenomena while opening new avenues for theoretical and observational exploration.

8.1. Next Theoretical Steps

Several extensions of this work will further establish NUVO as a viable cosmological model:

- **Modeling $\lambda(t)$ from first principles:** Rather than empirically fitting $\lambda(t)$ to match $H(z)$, we aim to derive its form from the NUVO field equation with scalar sources (as developed in Part 3).

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- **Nonlinear scalar wave behavior:** Structure formation, sinertia collapse, and gravitational radiation all depend on nonlinear dynamics of $\lambda(t, r)$. Simulating these behaviors in flat space is a high-priority objective.
- **Initial conditions and scalar coherence:** The replacement of inflation with initial scalar wave structures requires formal definition and simulation of the early λ field and its boundary constraints.
- **Covariant matter coupling:** The use of the NUVO covariant formalism (Part 5) will be extended to include radiation, baryons, and pinertia–sinertia feedback during early structure growth.

8.2. Simulation and Data Integration

To connect NUVO cosmology with observational data, a new class of simulations and analysis tools will be required:

- **Conformal cosmological simulations:** Large-scale structure formation using scalar field modulation in flat geometry.
- **Integration with BAO and redshift drift data:** Testing time evolution of $\lambda(z)$ against high-precision Hubble measurements.
- **CMB modeling:** Recomputing acoustic peak predictions using scalar perturbations rather than metric fluctuations.
- **Gravitational lensing paths:** Recasting light trajectories through scalar-modulated null geodesics to compare with lensing surveys.

8.3. Broader Implications

NUVO cosmology provides a unified platform where local gravitational phenomena and cosmological-scale behavior emerge from a single scalar field. This supports:

- A continuous bridge between quantum discreteness and cosmic evolution,
- Elimination of inflation, dark matter, and dark energy as separate postulates,
- A reinterpretation of cosmic acceleration and redshift as scalar modulation of time.

These advantages simplify the theoretical landscape while remaining consistent with existing observations — and they suggest new empirical tests capable of distinguishing scalar-modulated cosmology from curvature-based models.

8.4. Conclusion

NUVO cosmology replaces spacetime curvature with scalar modulation, offering a new path toward understanding redshift, expansion, and structure formation in a flat universe. This model retains observational success while eliminating theoretical complexity. With future work focused on field-theoretic modeling and simulation, NUVO provides a compelling and testable alternative cosmological framework rooted in conformal scalar dynamics.

8.5. Note on Theoretical Flexibility

While this paper presents a coherent cosmological framework within NUVO theory based on scalar field modulation, we emphasize that these specific interpretations of redshift, expansion, and structure formation are not necessarily final or definitive within NUVO.

As the theory matures, alternative or more refined mechanisms may arise that supersede the scalar explanations presented here. The conformal scalar field $\lambda(t, r, v)$ provides a powerful structure capable of supporting multiple geometric interpretations, and future developments in the NUVO series — particularly those concerning quantum emergence, covariant field dynamics, and gravitational radiation — may suggest new cosmological pathways.

Accordingly, the cosmological model described in this paper should be viewed as a viable proposal rather than a fixed prediction. It demonstrates how NUVO can account for key observations without curvature, but it does not constrain the theory to a single cosmological scenario.

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References

1. Austin, R.W. From Newton to Planck: A Flat-Space Conformal Theory Bridging General Relativity and Quantum Mechanics. *Preprints* **2025**. Preprint available at https://www.preprints.org/manuscript/202505.1410/v1.
2. Misner, C.W.; Thorne, K.S.; Wheeler, J.A. *Gravitation*; W. H. Freeman, 1973.
3. Damour, T.; Polyakov, A.M. Testing the equivalence principle: Torsion balance results and constraints on alternative theories. *Nuclear Physics B* **1994**, *423*, 532–558.
4. Will, C.M. The confrontation between general relativity and experiment. *Living Reviews in Relativity* **2014**, *17*, 1–117.
5. Perlmutter, S.; et al. Measurements of Ω and Λ from 42 high-redshift supernovae. *The Astrophysical Journal* **1999**, *517*, 565.