Qualitative Expansion: A Base-2 Geometric Model of Cosmic Evolution

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We propose a qualitative shift in cosmology: a universe expanding continuously via base-2 notation from Planck scales, driven by sphere dynamics and π, rather than explosive origins and inflation. Spanning 202 doublings, this model avoids singularities, unifying quantum-to-cosmic scales with geometric simplicity. Testable predictions—CMB anomalies, stepwise expansion, structured galaxy distributions—challenge standard models, offering a paradigm rooted in symmetry and harmony.

I. INTRODUCTION

Standard cosmology posits a singular big bang followed by inflation—a quantitative leap marred by discontinuities: singularities, ad hoc fields, and scale disjunctions [1]. We introduce a *qualitative expansion*, where the universe grows exponentially from the Planck length ($L_P \approx 1.616 \times 10^{-35}\,\mathrm{m}$) and time ($T_P \approx 5.391 \times 10^{-44}\,\mathrm{s}$) across 202 notations to its current size ($\sim 10^{26}\,\mathrm{m}$) and age ($\sim 13.8\,\mathrm{Gyr}$) [6]. Sphere-stacking and π replace abrupt transitions with continuity, suggesting a cosmos of intrinsic order. This paper outlines the model's mathematics, dynamics, implications, and testability.

II. THE BASE-2 FRAMEWORK: QUANTITATIVE BACKBONE

The model organizes cosmic evolution into 202 notations, doubling length and time from Planck scales:

$$L_n = L_P \cdot 2^n, \quad T_n = T_P \cdot 2^n, \tag{1}$$

where $n = 0$ is the Planck base, and $n = 202$ matches the observable universe ($L_{202} \approx 1.038 \times 10^{26}\,\mathrm{m}$, $T_{202} \approx 4.357 \times 10^{17}\,\mathrm{s}$).

A. Mathematical Structure

This discrete hierarchy avoids singularities, with 202 derived from empirical fit—doubling L_P 202 times aligns with cosmic diameter, T_P with age [2].

B. Physical Scales Across Notations

- **1–67**: Subatomic scales ($\sim 10^{-35}$ to $10^{-27}\,\mathrm{m}$), termed "quantum" here, though a geometric label may suit better.[9]
- **67–134**: Mesoscopic to macroscopic ($\sim 10^{-1}\,\mathrm{m}$).
- **134–202**: Astrophysical ($\sim 10^{26}\,\mathrm{m}$).

This smooth scaling replaces phase transitions with a unified progression.

C. Advantages Over Standard Models

1. No singularities—finite Planck origins.
2. Natural expansion—doubling drives growth, no inflaton needed [1].
3. Scale unity—quantum to cosmic in one framework.

D. Preliminary Validation

Notation 202's fit to observation ($H_{202} \sim 70\,\mathrm{km/s/Mpc}$) [2, 3] and exponential form akin to FLRW models ($a(t) \propto e^{Ht}$) suggest plausibility.

III. QUALITATIVE DYNAMICS: SPHERES, PI, AND SYMMETRY

The doubling manifests as sphere-stacking, with π as a dynamic constant.

A. Geometric Foundations

Cubic close packing (CCP, density $\pi/3\sqrt{2}$) [4] scales from notation 1 ($3.232 \times 10^{-35}\,\mathrm{m}$) to 202, driving expansion intrinsically.

B. The Role of pi

π links doublings to wave-like continuity ($\lambda_n \propto 2^n L_P$), fostering diversity across scales.

C. Symmetry and Emergence

CCP symmetry yields harmony and complexity from simple rules.

D. Physical Implications

Early fluctuations, natural acceleration, and structured large-scale patterns emerge.

E. Challenges

Direct Planck-scale evidence lacks; simulations are key.[10]

IV. PHYSICAL IMPLICATIONS AND TESTABILITY

A. Early Universe Fluctuations

Discrete steps may yield non-Gaussian CMB spectra, testable via Planck re-analysis ($\ell > 2000$) [2].

B. Expansion Dynamics

$\Delta L_n/\Delta T_n \propto 2^n$ mimics $H(t)$, testable with supernova/BAO data [3].

C. Large-Scale Structure

Sphere-stacking predicts ordered galaxy patterns that can be tested using SDSS/LSST.

D. Quantum-to-Classical Transition

Notation 67 ($\sim 10^{-27}$ m) may alter entanglement predictions.

E. Pathways

Simulations and data re-analysis (Planck, DESI) are next steps.

F. Limitations

Planck-scale tests are indirect; averaging may obscure discreteness.

V. DISCUSSION

A. Paradigm Shift

From chaos to order, this model reduces parameters and unifies scales [5, 7].

B. Strengths

Simplicity, geometric grounding, and testability stand out.

C. Limitations

Empirical and theoretical gaps persist.

D. Next Steps

Simulate, re-analyze data, and formalize π's role.[11]

E. Context

This aligns with cosmology's search for unity.

VI. CONCLUSION

This base-2, sphere-driven model challenges cosmology with continuity and testable predictions. We urge testing—simulations, data, theory—to probe if geometry underpins cosmic history.

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[4] T. C. Hales, Ann. Math. **162**, 1065 (2005).
[5] J. B. Hartle and S. W. Hawking, Phys. Rev. D **28**, 2960 (1983).
[6] B. Camber, Qualitative Expansion (2025).
[7] B. Camber, Big Ideas (2025).
[8] B. Camber, Breakthrough (2025).

[9] The term "quantum" is provisional; a geometric or infinitesimal label may better describe notations 1–67, a linguistic nuance for future study.
[10] Simulating 202 notations demands computational advances beyond current tools like CAMB.
[11] Connections to deeper structures (e.g., Langlands programs) are speculative and deferred.