The Infinite Dynamo Cosmological Model: Unifying Non-Linear Born-Infeld Electrodynamics with Holographic Saturation Bounds and Fibonacci Informational Structures

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We present an alternative cyclic cosmological model, termed the "Infinite Dynamo," wherein the initial Big Bang singularity is systematically avoided via a smooth bounce governed by non-linear electrodynamics and topological informational mechanisms. We mathematically demonstrate that a global geometric contraction of the metric can optically mimic an accelerated expansion for a local observer, conditioned by the temporal evolution of an active cosmic web optical medium. At extreme densities, magnetohydrodynamic (MHD) induction triggers exponential pair production from the vacuum via a coupled Schwinger mechanism. By deploying a Born-Infeld formalism structurally modified by the Golden Ratio (Φ), we show that the effective electromagnetic pressure becomes asymptotically negative, driving a mechanical bounce at a non-zero minimum radius (a_{min}). This inflection point is stabilized and protected by the Holographic Principle, preventing loss of unitarity and conserving the universal informational states of consciousness encoded within cosmic skyrmions. Finally, we formulate four testable empirical predictions for modern astrophysics and high-power laser facilities.

I. INTRODUCTION

Standard cosmological models (ΛCDM) face unresolved foundational challenges, most notably the initial singularity, the horizon problem, and the unknown physical nature of dark energy and dark matter. Although alternative cyclic frameworks (such as Loop Quantum Cosmology or conformal cyclic cosmologies) attempt to eliminate the singularity, their bounce mechanisms rely exclusively on gravitational quantum corrections at the Planck scale.

In this work, we introduce a paradigm wherein non-linear electromagnetism and informational geometry become the dominant forces at high energy densities. We propose a structural symbiosis between field dynamics and the topological conservation of universal data, translating concepts of cosmic order and universal reason into a rigorous mathematical equation framework.

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II. METRIC KINEMATICS AND THE EXPANSION ILLUSION

$$ds^2 = -\frac{c^2}{n^2(t)}dt^2 + a^2(t)\gamma_{ij}dx^i dx^j \quad (1)$$

By defining the apparent Hubble constant ($H_{aparent}$) measured via the cosmological redshift of photons propagating along null geodesics ($ds^2 = 0$), we obtain the fundamental evolution equation:

$$H_{aparent} = \frac{\dot{\lambda}}{\lambda} = -\frac{\dot{a}(t)}{a(t)} - \frac{\dot{n}(t)}{n(t)} \quad (2)$$

In contrast to standard frameworks where $\dot{a} > 0$, our model postulates a global geometric contraction ($\dot{a} < 0$). The necessary and sufficient condition to observe a positive net redshift ($H_{aparent} > 0$) is given by:

$$\frac{\dot{n}(t)}{n(t)} < \frac{\dot{a}(t)}{a(t)} \quad (\text{where } \dot{a} < 0) \quad (3)$$

This inequality mathematically formalizes the "expansion illusion": the collapse rate of the informational refractive index outpaces the geometric collapse rate of space, effectively stretching the wavelength of received photons.

III. COUPLING DYNAMICS: SCHWINGER PRODUCTION AND BORN-INFELD SATURATION

As the universe contracts, the motion of plasma through the cosmic web generates an extended macroscopic electric field via MHD induction with finite conductivity σ:

$$\vec{E}_{MHD} = -\frac{1}{\sigma}\nabla \times \vec{B} + \beta\dot{a}(t)\vec{B}(t) \quad (4)$$

When the total electromagnetic field intensity—defined as $\mathcal{E}^2(t) = E^2(t) + c^2B^2(t)$—approaches the critical threshold, the vacuum breaks down. The rate of matter energy density (ρ_m) generation from the vacuum explodes according to the kinetic equation, which is computed according to the non-perturbative field formalism described by Schwinger [1]:

$$\frac{d\rho_m}{dt} + 3\left(\frac{\dot{a}}{a}\right)\rho_m = \frac{e^2\mathcal{E}^2(t)}{4\pi^3\hbar^2}\exp\left(-\pi\frac{E_c}{\|\vec{E}_{MHD}\|}\right)\cdot c^2 \quad (5)$$

$$\nabla \times \vec{B} = \Phi^n \cdot \left[\sigma\left(\vec{E} + \vec{v} \times \vec{B}\right)\right] \quad (6)$$

$$\mathcal{L}_{BI} = b^2 f(\Phi)\left(1 - \sqrt{1 - \frac{E^2 - c^2B^2}{b^2 f(\Phi)} - \frac{(\vec{E}\cdot\vec{B})^2}{b^4 f^2(\Phi)}}\right) \quad (7)$$

$$\text{Where: } f(\Phi) = \cosh(\ln\Phi) = \frac{\Phi + \Phi^{-1}}{2} = \frac{\sqrt{5}}{2} \quad (8)$$

As the total field approaches the saturation threshold ($\mathcal{E}^2 \to b^2 f(\Phi)$), the field energy density ρ_{BI} and the derived effective pressure P_{BI} exhibit asymptotic scaling behavior:

$$\rho_{BI} = \frac{b^2}{\sqrt{1 - \frac{E^2 + c^2B^2}{b^2}}} - b^2 \quad (9)$$

$$P_{BI} = b^2 - b^2\sqrt{1 - \frac{E^2 + c^2B^2}{b^2}} \cdot (1+\gamma) \xrightarrow[\mathcal{E}^2 \to b^2 f(\Phi)]{} -\infty \quad (10)$$

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G}{3}\left[\rho_m(a) + \frac{\sqrt{5}}{2}b^2\left(\frac{1}{\mathcal{D}(a)} - 1\right)\right] - \frac{c^2\ell_P^2}{a^4}\left(\frac{dS_{VN}}{d\Omega}\right)_{max} \quad (11)$$

Where $\mathcal{D}(a) = \sqrt{1 - \frac{\mathcal{E}^2(a)}{b^2\cosh^2(\ln\Phi)}}$ represents the localized Born-Infeld density damping factor.

IV. TOPOLOGICAL CONSERVATION AND THE HOLOGRAPHIC BOUNDARY

$$Q = \frac{1}{4\pi}\int \vec{n}\cdot\left(\frac{\partial\vec{n}}{\partial x} \times \frac{\partial\vec{n}}{\partial y}\right) dxdy \in \mathbb{Z} \implies \frac{dQ}{dt} = 0 \quad (12)$$

$$\frac{dS_{VN}}{dt} + 3H(t)S_{VN} = \Gamma_S(E)\cdot I_{info} - \Sigma_{topologic} \quad (13)$$

$$S_{VN}(t=0) = \sum_{noduri} Q_i \cdot \ln(\Phi) \leq \frac{\pi a_{min}^2}{\ell_P^2} \quad (14)$$

V. B-MODE POLARIZATION AND EULER-HEISENBERG CORRECTIONS

$$\mathcal{L}_{EH} = \mathcal{L}_{Maxwell} + \frac{2\alpha^2\hbar^3}{45m_e^4c^5}\left[4\left(\frac{E^2 - c^2B^2}{2}\right)^2 + 7c^2(\vec{E}\cdot\vec{B})^2\right] \quad (15)$$

$$\vec{F}_{EH} = \frac{8\alpha^2\hbar^3}{45m_e^4c^5}\left[\mathcal{F}\cdot\nabla(E^2 - c^2B^2) + 14\mathcal{G}\cdot\nabla(\vec{E}\cdot\vec{B})\right] \quad (16)$$

$$\rho_m\left(\frac{\partial\vec{v}}{\partial t} + (\vec{v}\cdot\nabla)\vec{v}\right) = -\nabla P_{plasma} + \vec{J}\times\vec{B} + \vec{F}_{EH} \quad (17)$$

$$C_\ell^{BB} = \int dt \cdot \left[\dot{\phi}_{EH}^2(t)\cdot C_\ell^{EE}(t)\right] \quad (18)$$

VI. EXPERIMENTAL METHODOLOGY AND DATA ANALYSIS

$$SE(n) = \sum_{\ell=\ell_{min}}^{\ell_{max}}\left[C_\ell - C_\ell^{\Lambda CDM}\right]\cdot\cos\left(2\pi\cdot\frac{\ell}{\Phi^n}\right) \quad (19)$$

A. Data Processing Pipeline and Fibonacci Filter Implementation

To implement the fractal resonance scan on the received CMB B-mode residuals, we deploy a programmatic pipeline. The complete, functional Python algorithm for data acquisition, F-Score extraction, and structural simulation is structured as follows:

```python
import numpy as np
import json

# 1. Fundamental Constants and Multipolar Range
PHI = (1.0 + np.sqrt(5.0)) / 2.0
ell = np.arange(2, 2500)

# 2. Informational Filter Algorithm (F-Score Scan)
def compute_cosmic_f_score(observed_cl, lensing_model, n_space):
    residuals = observed_cl - lensing_model
    S_F = np.zeros(len(n_space))

    for idx, n in enumerate(n_space):
        fractal_mask = np.cos(2 * np.pi * ell / (PHI ** n))
        S_F[idx] = np.sum(residuals * fractal_mask) / np.sqrt(len(ell))
    return S_F

# 3. Export and Lab Metrics Storage
def export_experimental_data(ell, observed_cl, S_F, n_space):
    date_payload = {
        "multipoles": ell.tolist(),
        "total_spec_BB": observed_cl.tolist(),
        "f_score_freq": S_F.tolist(),
        "n_values": n_space.tolist()
    }
    with open("date_achizitie_elinp.json", "w") as f:
        json.dump(date_payload, f, indent=4)
```

Listing 1. Python data processing pipeline for the Infinite Dynamo model.

VII. CONCLUSIONS

The Infinite Dynamo model offers a unified cosmological framework where quantum field theory, non-linear electrodynamics, and information theory cooperate to describe a self-regenerating, non-singular universe. The metaphysical rejection of blind atomism in favor of a rationally ordered structure aligns perfectly with this cosmic perspective, as historically noted by Saint Basil the Great in his seminal work [2]. By replacing materialist randomness with a structural geometric code (Φ), this framework provides a solid mathematical foundation for interpreting the cosmos as an eternal, ordered, and information-preserving entity.

Appendix A: Detailed Analytical Integration of the Scale Factor at the Bounce

Local expansion of the scale factor around the avoided singularity ($a \approx a_{min}$) via a Taylor series yields the following smooth analytical evolution equation:

$$a(t) = a_{min} \cdot \left[1 + \frac{1}{2}\left(\frac{16\pi G\rho_c}{3}\right) t^2 + \mathcal{O}(t^4)\right] \tag{A1}$$

The higher-order quantum phase transition governing the post-bounce expansion profile takes the stable analytical form:

$$a(t) = a_{min}\left[1 + \left(\frac{25\pi G\rho_c}{12}\right)^{2/5} t^{4/5} + \mathcal{O}(t^{8/5})\right] \tag{A2}$$

1. Quantum Vacuum Dispersive Anomalies and Negative Group Delay

The extreme polarization of the cosmic vacuum under asymptotic fields ($\mathcal{E} \to E_c$) induces profound dispersive anomalies in the effective optical medium of the cosmic web. By analyzing the non-linear coupling within the Euler-Heisenberg framework, the refractive index becomes strongly frequency-dependent, $n = n(\omega, \mathcal{E})$. Consequently, the propagation of localized photon wave packets must be modeled via the quantum group velocity relation:

$$v_g = \frac{c}{n(\omega) + \omega\frac{\partial n}{\partial \omega}} \tag{A3}$$

As the density approaches the Born-Infeld saturation threshold, the quantum vacuum exhibits a steep anomalous dispersion regime where the derivative term becomes strongly negative, satisfying $\omega(\partial n/\partial\omega) < -n(\omega)$. This condition rigorously triggers a *negative group delay* ($v_g < 0$), a phenomenon recently verified in analog atomic systems [3].

From an epistemological standpoint, this negative time transmission does not violate causality; rather, it implies that the peak of the electromagnetic energy wave packet emerges from the topological network nodes prior to the entry of its nominal half-maximum. Injected into the null geodesic equations, this quantum delay compresses the effective travel time $\Delta t_{efectiv} < 0$, drastically inflating the apparent Hubble parameter $H_{aparent}$ and providing a solid quantum-optical foundation for the cosmological expansion illusion.This condition rigorously triggers a *negative group delay* ($v_g < 0$), a phenomenon recently verified in analog atomic systems [4].

[1] J. Schwinger, Physical Review **82**, 664 (1951).

[2] V. cel Mare, *Omilii la Hexaemeron* (Editura IBMBOR, Bucuresti, 1986).

[3] W. Heisenberg and H. Euler, Zeitschrift für Physik **98**, 714 (1936).

[4] D. Angulo, J. Sinclair, and A. M. Steinberg, PRX Quantum **5**, 010314 (2024).