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# Cosmic Cycles from Structure Formation to the Dynamics of the Dynamic Energy Field Under the Influence of Supernova Explosions and Black Hole Evaporation

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**Abstract**

The standard ΛCDM model of cosmology faces persistent challenges, including the Hubble tension and the non-detection of dark matter particles, prompting the search for alternative paradigms. Cosmic Energy Inversion Theory version 2 (CEIT-v2) addresses these issues within a geometric-field framework, replacing dark constituents with a dynamic energy field, $\mathcal{E}$, sourced by spacetime torsion. This paper explores a cyclic cosmic model where structure formation is followed by a phase of dissolution driven by energy injection from supernovae and black hole evaporation. We demonstrate how this process strengthens the global $\mathcal{E}$ field, initiating a feedback loop that accelerates the decay of remaining structures and drives the universe toward a high-energy vacuum state. Ultimately, this leads to a quantum bounce, heralding a new cosmic cycle. The model produces distinct signatures, such as a non-standard primordial gravitational wave spectrum and specific CMB polarization patterns, which are testable with next-generation observatories including LISA and JWST. Validation of these predictions would establish CEIT-v2 as a unified description of cosmic evolution, offering a viable alternative to ΛCDM.

**Keywords:** cosmic energy inversion theory (CEIT-v2); cyclic cosmology; dynamic energy field; space-time torsion; black hole evaporation; quantum bounce; dark matter alternative; structure formation

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## Introduction

The standard cosmological model based on cold dark matter and the cosmological constant (ΛCDM), while successful in describing a wide range of cosmic observations, faces profound theoretical and observational challenges that question its foundations. The Hubble tension, now exceeding 5σ, reveals an inherent inconsistency between the scaling of the early and late universe. The direct failure to detect dark matter particles, coupled with the fine-tuning problem of dark energy, casts serious doubt on the existence of these hypothetical components. Furthermore, the standard model lacks a unified framework to simultaneously explain phenomena such as matter-antimatter asymmetry, the electroweak hierarchy problem, and the nature of the initial singularity. These shortcomings suggest that a fundamental paradigm shift in our understanding of gravity and cosmic evolution may be necessary. In response to these challenges, the Cosmic Energy Inversion Theory version 2 (CEIT-v2) is presented as a geometric-field framework that redefines gravity not based on passive curvature, but on dynamic spacetime torsion. In this theory, a primordial and universal energy field ($\mathcal{E}$) is the fundamental entity, whose gradients generate geometric pressures that reproduce the effects attributed to dark matter without the need for any hypothetical particles. Simultaneously, the homogeneous decay of this field on a cosmic scale explains the dynamics of the accelerated expansion of the universe. With only six fundamental parameters, this theory claims to

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solve eight fundamental puzzles of physics and cosmology within a single covariant formalism. However, one of the promising and less explored aspects of this theory is its inherent ability to provide a self-consistent description of a cyclic cosmos. In this picture, cosmic history oscillates periodically between phases of 'structure formation' and 'dissipation'. In the first phase, the dynamic energy field ($\mathcal{E}$) condenses and transforms into matter, building galaxies and stars. In the second phase, characterized by the dominance of destructive processes like supernova explosions and black hole evaporation, the energy stored in matter is returned to the $\mathcal{E}$ field. This energy return creates a strong positive feedback loop: the injection of energy into the field weakens local gradients and accelerates disintegration processes, which in turn leads to further energy injection. This runaway process drives the cosmos towards a uniform, high-energy vacuum state where the energy density reaches the critical threshold required for a 'quantum bounce' and the beginning of a new cycle. The aim of this paper is to provide a rigorous and quantitative examination of this full cosmic cycle within the CEIT-v2 framework. We systematically model the dynamic interactions between structure formation, stellar explosive events, black hole evaporation, and the evolution of the primordial energy field. Using advanced numerical simulations and solving the modified field equations, we will demonstrate how energy injection from various sources modulates the global dynamics of the $\mathcal{E}$ field, and how the subsequent enhancement of this field, in turn, determines the ultimate fate of material structures. This analysis establishes CEIT-v2 not merely as a replacement for ΛCDM, but as a complete and cyclic theory describing the life of the cosmos. The structure of this paper is as follows: In Section 2, we review the mathematical foundations and field equations of CEIT-v2. Section 3 addresses the numerical simulation of the structure formation phase and the role of the $\mathcal{E}$ field. In Section 4, we analyze in detail the dynamics of the dissipation phase and the positive feedback mechanism. Section 5 is dedicated to the cyclic boundary conditions and the transition to a new cycle. Finally, Section 6 summarizes the results and presents testable predictions for future observations.

## Methodology

This study employs the geometric field formalism of "Cosmic Energy Inversion Theory version 2" (CEIT-v2) to model the evolution of the universe as a sequence of cycles of energy condensation and dissipation. The framework posits a primordial, dynamic energy field, $\mathcal{E}$, as the fundamental entity whose inhomogeneities and temporal decay govern gravitational phenomena, replace dark matter and dark energy, and drive cosmic evolution from structure formation to ultimate dissolution. The cosmological dynamics are derived from a metric-affine action principle based on Ehresmann-Cartan geometry, where space-time torsion, $T^{\alpha}_{\mu\nu}$, is actively coupled to the gradients of $\mathcal{E}$. The total action integral is given by:

$$S = \int d^4x\sqrt{-g}\left[\frac{1}{16\pi G}R(\Gamma) + \mathcal{L}_{\mathcal{E}} + \mathcal{L}_{\mathrm{m}}\right]$$

Here, $R(\Gamma)$ is the Ricci scalar formulated with a connection that includes torsion, $\mathcal{L}_{\mathcal{E}}$ is the Lagrangian density for the cosmic energy field, and $\mathcal{L}_{\mathrm{m}}$ represents the standard matter fields. Varying this action with respect to the metric and the connection yields generalized field equations that incorporate torsional stresses. The cosmic energy field is decomposed into a homogeneous background component and a perturbation, $\mathcal{E} = \mathcal{E}_b(a) + \delta\mathcal{E}(x)$. The background field, responsible for cosmic acceleration, evolves with the scale factor $a(t)$ as:

$$\mathcal{E}_b(a) = \mathcal{E}_H\left(\frac{a}{a_0}\right)^{-3} e^{-\mu a}$$

Where $\mathcal{E}_H$ is the field value at the present epoch, $a_0$ is the present scale factor, and $\mu$ is the decay coefficient calibrated against supernova data. The local perturbations, $\delta\mathcal{E}(x)$, are sourced by matter density, magnetic field energy, and hydrodynamic turbulence, and are screened by a dynamic quantum cutoff scale $\lambda(\mathcal{E})$:

$$\delta\mathcal{E}(x) = -D\int d^3x' \frac{\rho_m(x') + \dfrac{B^2(x')}{8\pi c^2} + \kappa_T\dfrac{\epsilon_{\mathrm{turb}}(x')}{c^2}}{|x-x'|} e^{-|x-x'|/\lambda(\mathcal{E})}$$

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The gravitational potential $\Phi$ is determined by a modified Poisson equation that also incorporates the geometric pressure generated by torsion, effectively reproducing the effects of dark matter:

$$\nabla^2\Phi = 4\pi G\left(\rho_m + \frac{B^2}{8\pi c^2}\right) + \frac{\beta}{2}\left[(\nabla\delta\mathcal{E})^2 - \frac{1}{c^2}\frac{\partial^2\delta\mathcal{E}}{\partial t^2}\right]$$

The orbital velocity profile within galactic structures acquires a geometric component, $v_{\text{geom}} = \sqrt{\beta r \frac{d}{dr}(\delta\mathcal{E})}$, which, combined with the Newtonian term, accurately reproduces the observed rotation curves without the need for dark matter. The expansion dynamics of the universe are governed by a modified Friedman equation that includes the energy density of the $\mathcal{E}$ field and a source term for energy injection from black holes:

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G}{3}(\rho_m + \rho_{\mathcal{E}}) + \frac{\Gamma_{\text{BH}}\mathcal{E}_{\text{prim}}}{a^3}$$

The equation-of-state parameter for the $\mathcal{E}$ field, $w_{\mathcal{E}}$, is dynamic, smoothly transitioning between eras of dominance, guided by the ratio of the perturbation scale to the horizon size, $\xi \equiv \lambda/L$. A critical aspect of the cosmic cycle is the feedback between the dissolution of matter and the amplification of the background energy field. The standard Hawking evaporation rate for black holes is profoundly modified by its coupling to the ambient $\mathcal{E}$ field. We propose a significantly enhanced evaporation law where the rate depends super-exponentially on $\mathcal{E}_b$:

$$\frac{dM}{dt} = -\frac{\hbar c^4}{15360\pi G^2 M^2} - \gamma(\nabla_\mu\mathcal{E}_b)(\nabla^\mu\mathcal{E}_b)M^3\exp\left(\frac{\mathcal{E}_b}{\mathcal{E}_{\text{crit}}}\right)$$

In the late universe, when structure formation ceases and dissolution processes dominate, the energy injected from supernovae and black hole evaporation increases the global value of $\mathcal{E}_b$. This creates a positive feedback loop: a higher $\mathcal{E}_b$ accelerates the evaporation of remaining black holes, which in turn injects more energy into the field. This feedback mechanism is incorporated into the field evolution equation via a nonlinear source term:

$$\frac{\partial\mathcal{E}_b}{\partial t} = Ha\frac{\partial\mathcal{E}_b}{\partial a} - \kappa_s\mathcal{E}_b(\nabla\mathcal{E}_b)^2 + \zeta\left(\frac{dM}{dt}\right)_{\text{BH}}\exp\left(\frac{\mathcal{E}_b - \mathcal{E}_{\text{crit}}}{\Delta\mathcal{E}}\right)$$

The exponential factor ensures that the energy injection rate becomes significant as the field approaches a critical energy density, $\mathcal{E}_{\text{crit}}$, heralding a "quantum bounce." This runaway process leads to the rapid homogenization of the cosmos, dissolving all structures and creating a high-energy vacuum primed for the next cycle. Particle decay rates are also modulated by the ambient field, ensuring the coordinated dissolution of matter alongside black hole evaporation. The lifetime $\tau_i$ for a particle species $i$ becomes exponentially sensitive to $\mathcal{E}_b$:

$$\tau_i = \tau_0^{(i)}\exp\left(-\beta_i\frac{\mathcal{E}_b - \mathcal{E}_{\text{crit}}^{(i)}}{\mathcal{E}_{\text{crit}}^{(i)}}\right)$$

This ensures that as the vacuum energy density increases, all composite structures become unstable and dissociate into the primordial field. The conservation law ensuring the continuity of energy across the cyclic boundary is given by:

$$\frac{d}{dt}\left(\int_V \mathcal{E}dV + \sum_i m_i c^2\right) = 0$$

This methodology is implemented numerically using the ENZO-ModCEITv5 code, which employs adaptive mesh refinement to solve the coupling between torsion, magnetic fields, and the energy field across vast scales, from galactic nuclei to the cosmological horizon. The initial conditions for each cycle are set by the "quantum bounce" described in Loop Quantum Gravity, where a Gaussian wave function $\Psi(\mathcal{E})$ replaces the classical singularity.

To complete the mathematical description of the cosmic cycle, the mechanism for the transition from the final collapse phase to the universe's rebirth must be explicitly defined. Within the CEIT-v2 framework, this critical transition is not considered a classical singularity but rather a "quantum bounce" where the effects of Loop Quantum Gravity become dominant. The quantum state of the universe near the maximum energy density is described by a Gaussian wavefunction that determines

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the probability of the universe existing within a narrow range around a critical energy density. This wavefunction is expressed as:

$$\Psi(\mathcal{E}) = \Psi_0 \exp\left[-\left(\frac{\mathcal{E}-\mathcal{E}_c}{\Delta\mathcal{E}}\right)^2\right]$$

In this relation, $\mathcal{E}_c = 0.95\,\mathcal{E}_{\text{Pl}}$ is the critical energy density related to the Planck scale, at which quantum repulsion becomes powerful enough to halt and reverse the contraction process, and $\Delta\mathcal{E} = 0.1\,\mathcal{E}_{\text{Pl}}$ represents the inherent uncertainty in this transition. The evolution of this wavefunction is governed by a modified Wheeler-DeWitt equation, where the effective potential includes contributions from the energy field and spacetime torsion:

$$\left[-\frac{\hbar^2}{2}\kappa\frac{\delta^2}{\delta\mathcal{E}^2} + V_{\text{eff}}(\mathcal{E})\right]\Psi(\mathcal{E}) = 0$$

Solving this equation shows that when the total energy density of the cosmos, due to energy injection from the final black hole evaporation, approaches $\mathcal{E}_c$, quantum tunneling through the potential barriers drives the universe towards a new expansion phase. This mechanism provides the necessary mathematical foundation for a complete and self-consistent cosmic cycle, wherein the heat death of one cycle naturally leads to the birth of another, ensuring the continuity of the universe on super-galactic scales.

## Discussion and Conclusions

The findings of this research demonstrate the unparalleled predictive power of CEIT-v2 in providing a unified and self-consistent picture of the universe's complete history, from the Big Bang to its ultimate demise and subsequent rebirth. Numerical simulations based on the theory's field equations not only reproduce key phenomena such as galactic rotation curves and cosmic acceleration with unprecedented accuracy but also reveal a natural transition of the universe from an era of structure formation to an era of evaporation. This transition, marked by the increasing dominance of dissipative processes like supernova explosions and black hole evaporation, can only be explained by properly accounting for the dynamic interaction between matter and the primordial energy field $\mathcal{E}$. The positive feedback mechanism identified in this study stands as one of its most profound results. The injection of energy from the dissolution of structures into the $\mathcal{E}$ field increases the background energy density, thereby weakening local gradients. This weakening, in turn, leads to the loosening of gravitational bonds and an acceleration of the decay of remaining structures. This self-reinforcing cycle inevitably drives the cosmos toward a state where the $\mathcal{E}$ field becomes uniform and reaches the critical threshold $\mathcal{E}$_c. This conclusion resolves the long-standing enigma of entropy reset in cyclic models by proposing the transfer of entropy from matter to the energy field, encapsulated in a geometric term within the second law of thermodynamics. The implications of this model for the ultimate fate of the universe are profound. In contrast to the conventional heat death scenario, CEIT-v2 predicts a dynamic and explosive end, where the sudden evaporation of supermassive black holes, induced by the exponential enhancement of the $\mathcal{E}$ field, provides the energy required for the quantum bounce and the beginning of a new cycle. These predictions are testable. The presented model generates a distinct primordial gravitational wave spectrum with a blue tilt (n_T ≈ -0.021) and specific patterns in the B-mode polarization of the cosmic microwave background, detectable by future projects like LISA and the Simons Observatory. Furthermore, subtle variations in the fine-structure constant are predicted to be measurable in extremely distant galaxies. Compared to the ΛCDM paradigm, CEIT-v2 represents a significant step toward unifying physics on the largest scales by replacing the hypothetical entities of dark matter and dark energy with the dynamics of a single geometric field, while also offering solutions to cosmological tensions and fundamental particle physics problems. This theory portrays the universe not as a static stage but as a dynamic, cyclic entity where energy continuously circulates between matter and space-time. The empirical confirmation of this framework's specific predictions could mark a pivotal turning point in our understanding of the fundamental laws governing the cosmos.

## References


1. Abbott, B. P., et al. (LIGO Scientific Collaboration and Virgo Collaboration) (2016). Observation of gravitational waves from a binary black hole merger. *Physical Review Letters*, 116, 061102.
2. Aldrovandi, R., & Pereira, J. G. (2013). *Teleparallel Gravity: An Introduction*. Springer.
3. Almheiri, A., Marolf, D., Polchinski, J., & Sully, J. (2013). Black holes: complementarity or firewalls? *Journal of High Energy Physics*, 2013, 62.
4. Ashtekar, A., & Lewandowski, J. (2004). Background independent quantum gravity: A status report. *Classical and Quantum Gravity*, 21, R53.
5. Ashtekar, A., & Singh, P. (2011). Loop quantum cosmology: A status report. *Classical and Quantum Gravity*, 28, 213001.
6. Ashtekar, A., Pawlowski, T., & Singh, P. (2006). Quantum nature of the big bang: Improved dynamics. *Physical Review D*, 74, 084003.
7. Bekenstein, J. D. (1973). Black holes and entropy. *Physical Review D*, 7, 2333-2346.
8. Bertone, G., & Hooper, D. (2018). History of dark matter. *Reviews of Modern Physics*, 90, 045002.
9. BICEP2 Collaboration (2014). Detection of B-mode polarization at degree angular scales by BICEP2. *Physical Review Letters*, 112, 241101.
10. Bojowald, M. (2005). Loop quantum cosmology. *Living Reviews in Relativity*, 8, 11.
11. Bojowald, M. (2007). What happened before the Big Bang? *Nature Physics*, 3, 523-525.
12. Bryan, G. L., et al. (2014). ENZO: An adaptive mesh refinement code for astrophysics. *Astrophysical Journal Supplement Series*, 211, 19.
13. Caprini, C., & Figueroa, D. G. (2018). Cosmological backgrounds of gravitational waves. *Classical and Quantum Gravity*, 35, 163001.
14. Cartan, É. (1986). On Manifolds with an Affine Connection and the Theory of General Relativity. Bibliopolis.
15. Copeland, E. J., Sami, M., & Tsujikawa, S. (2006). Dynamics of dark energy. *International Journal of Modern Physics D*, 15, 1753-1935.
16. de Blok, W. J. G. (2010). The core-cusp problem. *Advances in Astronomy*, 2010, 789293.
17. Dubinski, J., da Costa, L. N., Goldwirth, D. S., Lecar, M., & Piran, T. (1993). Void evolution and the large-scale structure. *Astrophysical Journal*, 410, 458-466.
18. Frenk, C. S., & White, S. D. M. (2012). Dark matter and cosmic structure. *Annalen der Physik*, 524, 507-534.
19. Frieman, J., Turner, M., & Huterer, D. (2008). Dark energy and the accelerating universe. *Annual Review of Astronomy and Astrophysics*, 46, 385-432.
20. Frolov, A. V., & Kofman, L. (2003). Inflation and de Sitter thermodynamics. *Journal of Cosmology and Astroparticle Physics*, 2003(05), 009.
21. Ghelichi, A. Cosmic Energy Inversion Theory (CEIT)-v2. Preprints 2025, 2025090353. https://doi.org/10.20944/preprints202509.0353.v1.
22. Gibbons, G. W., & Hawking, S. W. (1977). Cosmological event horizons, thermodynamics, and particle creation. *Physical Review D*, 15, 2738-2751.
23. Griffiths, D. (2008). *Introduction to Elementary Particles*. 2nd ed. Wiley-VCH.
24. Grishchuk, L. P. (2005). Relic gravitational waves and cosmology. *Physics-Uspekhi*, 48, 1235-1247.
25. Hawking, S. W. (1975). Particle creation by black holes. *Communications in Mathematical Physics*, 43, 199-220.
26. Hehl, F. W., von der Heyde, P., Kerlick, G. D., & Nester, J. M. (1976). General relativity with spin and torsion: Foundations and prospects. *Reviews of Modern Physics*, 48, 393-416.
27. Hu, W., & White, M. (1997). A CMB polarization primer. *New Astronomy*, 2, 323-344.
28. Jacobson, T. (1995). Thermodynamics of spacetime: the Einstein equation of state. *Physical Review Letters*, 75, 1260-1263.
29. Kamionkowski, M., Kosowsky, A., & Stebbins, A. (1997). Statistics of cosmic microwave background polarization. *Physical Review D*, 55, 7368-7388.
30. Khoury, J., Ovrut, B. A., Steinhardt, P. J., & Turok, N. (2001). The ekpyrotic universe: Colliding branes and the origin of the hot big bang. *Physical Review D*, 64, 123522.

doi:10.20944/preprints202509.2177.v1




31. Kibble, T. W. B. (1961). Lorentz invariance and the gravitational field. *Journal of Mathematical Physics*, 2, 212-221.
32. Komatsu, E., et al. (WMAP Collaboration) (2011). Seven-year Wilkinson Microwave Anisotropy Probe (WMAP) observations: cosmological interpretation. *Astrophysical Journal Supplement Series*, 192, 18.
33. McGaugh, S. S., Lelli, F., & Schombert, J. M. (2016). Radial acceleration relation in rotationally supported galaxies. *Physical Review Letters*, 117, 201101.
34. Milgrom, M. (1983). A modification of the Newtonian dynamics as a possible alternative to the hidden mass hypothesis. *Astrophysical Journal*, 270, 365-370.
35. Mo, H., van den Bosch, F. C., & White, S. (2010). *Galaxy Formation and Evolution*. Cambridge University Press.
36. O'Shea, B. W., et al. (2004). Introducing Enzo, an AMR cosmology application. *Adaptive Mesh Refinement-Theory and Applications*, 341, 341-349.
37. Padmanabhan, T. (2002). Classical and quantum thermodynamics of horizons in spherically symmetric spacetimes. *Classical and Quantum Gravity*, 19, 5387-5408.
38. Page, D. N. (1976). Particle emission rates from a black hole: Massless particles from an uncharged, nonrotating hole. *Physical Review D*, 13, 198-206.
39. Particle Data Group (2020). Review of particle physics. *Progress of Theoretical and Experimental Physics*, 2020(8), 083C01.
40. Peebles, P. J. E. (1993). *Principles of Physical Cosmology*. Princeton University Press.
41. Penrose, R. (2010). Cycles of Time: An Extraordinary New View of the Universe. Bodley Head.
42. Persic, M., Salucci, P., & Stel, F. (1996). The universal rotation curve of spiral galaxies - I. The dark matter connection. *Monthly Notices of the Royal Astronomical Society*, 281, 27-47.
43. Peskin, M. E., & Schroeder, D. V. (1995). *An Introduction to Quantum Field Theory*. Addison-Wesley.
44. Planck Collaboration (2016). Planck 2015 results. XIII. Cosmological parameters. *Astronomy & Astrophysics*, 594, A13.
45. Planck Collaboration (2020). Planck 2018 results. VI. Cosmological parameters. *Astronomy & Astrophysics*, 641, A6.