Dynamic Vacuum Field Theory Adapted to T0 Theory

Chapters 9–12

Based on work by Satish B. Thorwe
Adapted to T0 Theory Framework

December 25, 2025

T0 Theory Framework

This document presents Dynamic Vacuum Field Theory (DVFT) adapted to align with T0 Theory as its fundamental basis. T0 Theory provides the conclusive core framework with:

- Time-mass duality: $T(x,t) \cdot m(x,t) = 1$
- Fundamental parameter: $\xi = \frac{4}{3} \times 10^{-4}$
- Simplified Lagrangian: $\mathcal{L} = \varepsilon(\partial\Delta m)^2$
- Extended Lagrangian including time-field interactions
- Node dynamics for particles and spin

DVFT is reformulated as a phenomenological layer on T0, deriving its vacuum field $\Phi = \rho e^{i\theta}$ directly from T0 principles.

Contents

1 STRONG, WEAK, AND DEEP FIELD PHYSICS

1.1 Introduction

Dynamic Vacuum Field Theory (DVFT) predicts distinct regimes of gravitational behavior determined by the magnitude of the vacuum phase gradient

$$X = -g$$

$\mu\ \partial\mu\theta\ \partial\theta.$

These regimes—strong field, weak field, deep field, and an ultra-deep cosmological regime—correspond to different nonlinear responses of the vacuum. This chapter provides a unified description of vacuum behavior from local strong-gravity environments to the largest cosmological scales where dark energy dominates.

1.2 Strong Field Regime (X » a²)

In high-acceleration environments such as near stellar surfaces, neutron stars, or black hole exteriors, phase gradients are large. The vacuum response

$$L_X =$$

∂Lθ/∂X

approaches an almost constant value: L$_X\approx \rho/2$. Nonlinear terms in the Lagrangian, International Journal for Multidisciplinary Research (IJFMR) E-ISSN: 2582-2160 • Website: www.ijfmr.com • Email: editor@ijfmr.com IJFMR250664112 Volume 7, Issue 6, November-December 2025 22

$$L$$

θ = $(\rho/2)$ X - $(/(3\ a_0^2))X^{3/2}-\Lambda_v$,

become negligible compared to the linear X term. In this limit DVFT reduces to the predictions of General Relativity with an effective cosmological constant $\Lambda_e ffsetbytheresidualvacuumte$ $linearresponseof\theta$, and conventional GR tests are satisfied.

1.3 Weak Field Regime (X a²)

As accelerations approach a$_0$, $nonlinearvacuumeffectsbegintocontribute.HereXiscomparabletoa_0^2andt$
- $(/(2\ a_0^2))X^{1/2}$

departs from a constant and begins to depend on the local phase gradient. Observable consequences include:

- small deviations from Newtonian potential in extended systems,
- mild corrections to post-Newtonian parameters,
- subtle modifications to gravitational lensing and Shapiro delay.

This regime provides a smooth transition between pure GR behavior in strong fields and the deep field behavior that governs galactic outskirts.

1.4 Deep Field Regime (X « a², Galactic Scale)

The deep field regime governs low-acceleration environments such as the outskirts of spiral galaxies. In this limit phase gradients are small, but the nonlinear $X^{3/2} termdominatestheresponseofthe$ and enforcing scale invariance leads to an effective vacuum energy density scaling as: $E_v ac|\nabla\phi|^3, where\phi$ is the gravitational potential related to θ through the background dynamic vacuum field. The resulting field equation in the non-relativistic limit becomes:

$\nabla \cdot [(|\nabla\phi|/a_0)\nabla\phi] = 4\pi G\ \rho_b$,

where $\rho_b isthebaryonicmatterdensity.Forsphericalsystemsthisgives : g^2(r) = a_0 g_N(r)$,

with g the true gravitational acceleration and $g_N theNewtonianaccelerationfrombaryonsalone.Thispro$

flat rotation curves,

$$thebaryonicTully\breve{}Fisherrelationv_c = GM_b a_0,$$

no requirement for dark matter halos.

Thus the deep field regime is responsible for MOND-like behavior emerging naturally from DVFT vacuum microphysics.

1.5 Ultra-Deep Cosmological Regime (g « a, Dark Energy Scale)

On scales comparable to or larger than the Hubble radius, typical gravitational accelerations become far smaller than $a_0.Inthisultra-deepregime, phasegradientsareextremelysm$ are suppressed relative to the residual vacuum term. The vacuum field approaches: $\Phi \approx \rho\infty\ e^i\mu$ t, with $\rho\infty$ a nearly homogeneous amplitude and μ the dynamic vacuum field frequency. The effective energy density and pressure of the vacuum become: $\epsilon_v ac \approx\ \rho\infty^2\mu^2 + V(\rho\infty)$, $p_v ac \approx\ \rho\infty^2\mu^2 - V(\rho\infty)$, International Journal for Multidisciplinary Research (IJFMR) E-ISSN: 2582-2160 • Website: www.ijfmr.com • Email: editor@ijfmr.com IJFMR250664112 Volume 7, Issue 6, November-December 2025 23 where $V(\rho)$ is the vacuum potential. For parameter choices where $V(\rho\infty)$ dominates over the kinetic term, one obtains: $p_v ac\approx$ $-\epsilon_v ac, whichcorrespondstoanequationofstateparameterw\approx$ -1. This is the dark-energy-like regime of DVFT: the universe is driven by residual dynamic vacuum field energy and the nearly constant vacuum potential. In this ultra-deep regime:

- $X \to 0$,
- $L_X \to \rho/2$,
- the stress–energy tensor of θ reduces to an effective cosmological constant term,
- the Friedmann equations predict accelerated expansion.

Thus, dark energy is not an independent fluid but the asymptotic vacuum state of Φ when typical gravitational gradients fall far below $a_0 oncosmologicalscales$.

1.6 Transitions Across Scales

The three local regimes (strong, weak, deep) and the ultra-deep cosmological regime are not separate theories; they are different limits of the same underlying dynamics controlled by X and the parameters $(\rho, , \mathrm{a}_0,\Lambda_v). Asacharacteristicaccelerationinasystemchanges, thevacuumsmoo$

GR-like behavior in compact objects and Solar System tests,

modified dynamics in galaxies (deep field),

effective dark energy at horizon-scale averages (ultra-deep field).

The governing equation

$$\nabla\mu\ (\mathrm{L}_X \nabla\mu\ \theta) = 0$$

determines how the phase field adjusts across these regimes. Small, local systems never probe the ultradeep vacuum; galaxies probe the deep-field regime; the universe as a whole samples the full vacuum potential and residual dynamic vacuum field energy.

1.7 Implications for Cosmology and Structure Formation

Because the same Lagrangian $\mathrm{L}\theta$ governs all regimes, DVFT ties together:

- galactic rotation curves,
- cluster dynamics,
- cosmic acceleration,
- the absence of singularities,
- with a single set of vacuum parameters. Structure formation proceeds in a background where:
- early universe: kinetic and potential terms of Φ drive inflation-like expansion,
- intermediate epochs: matter dominates and deep-field corrections shape halo dynamics,
- late universe: ultra-deep regime emerges, and dark-energy-like behavior dominates.

In contrast to ΛCDM, where dark matter and dark energy are independent components, DVFT describes both as manifestations of one vacuum field, viewed in different acceleration regimes.

1.8 Summary

DVFT organizes gravitational behavior into four coherent regimes:

- Strong field: GR limit, X » $a_0^2, linear response, compact objects. Weak field: transitional, X\ a_0^2, small nonlinear corrections.$

- Deep field: galactic scale, X « $a_0^2 but gradients still relevant, g^2 = a_0 g_N, no dark matter.$
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- Ultra-deep cosmological field: g « $a_0 on horizon scales, residual vacuum energy acts as dark ene$
  ≈ -1). This regime structure is not an artificial phenomenology; it is the natural consequence of a single dynamic vacuum field Lagrangian. As a result, DVFT provides a unified physical explanation for local gravity tests, galaxy dynamics, and late-time cosmic acceleration within one coherent framework.

2 DARK ENERGY REINTERPRETATION

2.1 Introduction

This document presents a strict DVFT-based derivation of dark energy, with no reference to external darkenergy models. The goal is to show how cosmic acceleration arises solely from the vacuum amplitude ρ and its microphysical potential U(ρ). We derive the full equations for DVFT dark energy, specify U(ρ) from the DVFT micro-lattice model, and compare DVFT predictions directly with observed cosmological values. Fundamental DVFT vacuum field:

Φ(x,t) = ρ(x,t) e$^{i}\theta$(x,t).

The universe's large-scale behavior emerges from the homogeneous evolution of ρ(t), while θ(t) controls quantum-phase structure.

2.2 DVFT Vacuum Lagrangian in a Homogeneous Universe

From DVFT microphysics, the effective continuum vacuum Lagrangian is:

$${}_vac = (A$$

$\rho/2)(\partial_t\rho)^2 - (B\rho/2)|\nabla\rho|^2 + (A\theta/2)\rho^2(\partial_t\theta)^2 - (B\theta/2)\rho^2|\nabla\theta|^2 - U(\rho).$

$$For a homogeneous FRW universe($$

ρ(t), θ(t), $\nabla\rho = \nabla\theta = 0$):

$${}_hom = (A$$

$\rho/2)\rho^2 + (A\theta/2)\rho^2\theta^2 - U(\rho).$

All cosmological dark-energy effects will arise directly from this expression. No additional fluids or fields are introduced.

2.3 Vacuum Energy Density and Pressure from DVFT

Define kinetic energy of the vacuum amplitude–phase system:

$$K = (A$$

$\rho/2)\rho^2 + (A\theta/2)\rho^2\theta^2$.

DVFT vacuum behaves as a perfect fluid with:

$\rho_D VFT = K + U(\rho)$,p$_D VFT = K - U(\rho)$.

The effective equation-of-state is:

$$w_D VFT = (K - U)/(K + U).$$

Important limits:

- K U → w → -1 (dark-energy–like)
- K U → -1 < w < -1/3 (dynamical dark energy)
- K U → w → +1 (stiff fluid; irrelevant today)

2.4 Dark-Energy Evolution Equation in DVFT

Varying the homogeneous action yields the amplitude evolution equation:

$$A$$

$\rho(\rho+$ 3H$\rho)$ - A$\theta\rho$ $\theta^2 + dU/d\rho = 0$,

where: H = /a (Hubble parameter). At late times, the cosmic phase tends to freeze on large scales ($\theta \approx 0$), reducing the equation to:

$$A$$

$\rho(\rho+$ 3H$\rho)$ + dU/dρ = 0.

International Journal for Multidisciplinary Research (IJFMR) E-ISSN: 2582-2160 • Website: www.ijfmr.com • Email: editor@ijfmr.com IJFMR250664112 Volume 7, Issue 6, November-December 2025 25 This is the DVFT dark-energy equation: the cosmic vacuum amplitude ρ evolves in its potential U(ρ) under Hubble damping.

2.5 Microphysical Form of U() in DVFT

DVFT is based on a micro-lattice vacuum with local Hamiltonian:

$$H_loc = p$$

$\rho^2/(2M\rho)$ + p$\theta^2/(2M\theta\ \rho^2) + U_loc(\rho)$.

DVFT microphysics requires U$_loc(\rho)$ to have:

- a stable minimum at ρ (preferred vacuum amplitude),
- positive curvature at ρ (vacuum stiffness),
- anharmonic corrections stabilizing deviations.

Thus the coarse-grained continuum potential becomes:

$$U($$

$\rho) = \Lambda$ + $(/2)(\rho$ - $\rho)^2 + (\lambda/4)(\rho$ - $\rho)$ + ...

Where:

- $$\Lambda = \text{microphysical residual vacuum energy density},$$
- = vacuum amplitude compressibility,
- $$\lambda = \text{higher-order stabilization}.$$

Near the minimum: U$(\rho) \approx \Lambda$ + (1/2)m$\rho^2(\rho$ - $\rho)^2, with m\rho^2 = /A\rho.$

This U(ρ) is not arbitrary; it is derived from DVFT vacuum elasticity and amplitude stability.

2.6 DVFT Explanation for Dark Energy on Cosmic Scales

DVFT predicts dark energy because:

2.7 The vacuum amplitude has a preferred value (microphysical equilibrium).

2.8 The local vacuum energy density U() = is *not zero*.

2.9 On large scales, (t) approaches and remains nearly constant due to strong Hubble damping.

2.10 Therefore, the vacuum behaves like a nearly constant energy density with w -1.

The measured value: $\rho\Lambda \approx 7 \times 10^2 kg/m^3 \Omega\Lambda \approx$ 0.70–0.75 matches DVFT if:

$\Lambda =$ U(ρ) $\approx$ 0.7 $\rho_c rit.$

Thus dark energy is the "elastic offset energy of the vacuum amplitude"

2.11 Why U() Is Negligible on Solar and Galactic Scales

A uniform vacuum energy density produces acceleration: g$_v ac(r)$$\approx$ (8πG/3) $\rho\Lambda$ r. At solar scale (r = 1 AU): g$_v ac$ $10^2 m/s^2 (negligible).Atgalacticscale(r = 10kpc) : g_v ac$ $10 m/s^2 (stillnegligible).Thus :$

Local dynamics are governed by $\nabla\rho$ and matter coupling, not U(ρ).

Vacuum elasticity only influences cosmic expansion where r giga-parsecs.

DVFT cleanly separates:

- Galactic gravity: amplitude gradients $\nabla\rho$ dominate.

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- Cosmological acceleration: homogeneous U(ρ) dominates.

2.12 Numerical Comparison with Observations

Given:

- $H_0 \approx$ 67–70 km/s/Mpc,

- $$\rho_c rit = 3H_0^2/(8\pi\mathrm{G}),$$

- $\Omega\Lambda \approx 0.7$,

DVFT requires:

$$U($$

$\rho) = \Lambda \approx 0.7\ \rho_c rit.$

This matches observational values from CMB, BAO, and SN data. Moreover, if ρ(t) is still slowly relaxing toward ρ, then: w$_D VFT \approx$ -1 + 2K/U, allowing mild deviations from -1 (observationally allowed), and potentially matching evolving darkenergy hints from DESI.

2.13 Summary

From strict DVFT principles, dark energy arises from the vacuum amplitude's microphysical potential:

$$U($$

$\rho) = \Lambda$ + (/2)(ρ - $\rho)^2$ + (λ/4)(ρ - ρ) + . . .

Key results:

- $$\rho_D VFT = K + U(\rho),\ \mathrm{p}_D VFT = K - U(\rho).$$

- $$w_D VFT = (K - U)/(K + U).$$

- $$Vacuumamplitudeevolvesvia A$$

  $\rho(\rho$+ 3Hρ) + U'(ρ) = 0.

- On cosmic scales, $\rho \approx \rho$ w $\approx$ -1, matching dark-energy observations.
- On solar/galactic scales, U(ρ) is negligible; $\nabla\rho$ dominates gravity.
- DVFT dark energy matches measured values $\Omega\Lambda \approx 0.7$ and w $\approx$ -1 with no additional fields.

Thus DVFT naturally unifies local gravity and cosmic acceleration using only vacuum amplitude physics.

3 BLACK HOLE INTERIOR PREDICTION

This chapter presents a complete description of black hole interiors in the Dynamic Vacuum Field Theory(DVFT). DVFT replaces the classical singularity of General Relativity (GR) with a finite-density quantum vacuum core, using a nonlinear phase field θ. Both the mathematical structure and the physical interpretation are provided.

3.1 DVFT Overview

DVFT treats spacetime as a quantum vacuum medium described by a complex order parameter:

$\Phi = \rho$ $\mathrm{e}^{i}\theta$

Gravity arises from dynamic vacuum field with amplitude ρ and phase θ. The Lagrangian contains nonlinear kinetic terms:

$$L$$

$\theta =$ -$\Lambda_v + (\rho_0/2)X - (/(3a_0^2))X^{3/2} with X = -g\mu\ \partial\mu\theta\ \partial\theta.$

At large accelerations (g » a_0), $DVFT reduces to GR. At small accelerations (g << a_0), nonlinearities appear.$

3.2 Black Hole Metric and Field Ansatz

We use the standard static spherically symmetric metric:

$$ds^2 = -e^2$$

Φ(r)d$t^2 + dr^2/(1 - 2Gm(r)/r) + r^2 d\Omega^2$.

International Journal for Multidisciplinary Research (IJFMR) E-ISSN: 2582-2160 • Website: www.ijfmr.com • Email: editor@ijfmr.com IJFMR250664112 Volume 7, Issue 6, November-December 2025 27

$$The vacuum phase depends only on radius:$$

$\theta = \theta$(r). The kinetic invariant becomes:X = -(1 - 2Gm(r)/r) θ'(r)^2. From the k-essence stress-energy tensor:

$$T$$

$\mu =$ 2 $\mathrm{L}_X \partial\mu\theta\ \partial\theta$ - gμ Lθ

3.3 Stress-Energy Components

Define:

$$L$$

$\theta = -\Lambda_v + (\rho_0/2)X - (/(3a_0^2))X^{3/2}$,

$$L_X =$$

$\partial L\theta/\partial X = \rho_0/2 - (/(2a_0^2))X^{1/2}. Energydensityandpressures : \rho = L\theta, p_t = \rho, p_r = 2L_X X - L\theta.$

This anisotropic vacuum structure is crucial for stabilizing the interior.

3.4 Vacuum Saturation Mechanism

$$Thescalarfieldequation$$

$\nabla\mu(L_X\partial\mu\theta)=0$ is satisfied in the core when:$L_X(X_0) = 0. Setting L_X = 0 gives : X_0^{1/2} = (\rho_0 a_0^2)/$. Thus, the vacuum phase reaches a 'saturation' point $X_0, limiting further compression. The coree$ $-\Lambda_v + (\rho_0^3 a_0)/(6^2)$.

3.5 Core Geometry

$$With$$

$\rho = \rho_c ore = constant, the Einstein equation gives ade Sitter\breve{} like interior : m(r) = (4\pi/3)\rho_c ore r^3,$

$$1 - 2Gm(r)/r = 1 - (8$$

$\pi G/3)\rho_c ore r^2. Thus, the interior metric is :$

$ds_c^2 ore \approx -[1 - (\Lambda_e ff r^2)/3]dt^2 + dr^2/[1 - (\Lambda_e ff r^2)/3] + r^2 d\Omega^2, with \Lambda_e ff = 8\pi G\ \rho_c ore.$

There is no singularity; curvature remains finite.

3.6 Matching to Exterior Geometry

For r > $r_c(core radius), X << X_0 and nonlinear effects vanish. DVFT reduces to GR : ds^2 \approx$ Schwarzschild metric. Matching conditions ensure:

$$g_{tt}(core) = g_{tt}(ext),$$

$$g_{rr}(core) = g_{rr}(ext).$$

Thus, DVFT describes a black hole with a GR exterior and a finite-density vacuum core interior.

3.7 Physical Interpretation (Non-Mathematical)

- GR predicts infinite collapse. DVFT prevents this by saturating the vacuum phase.
- The black hole interior becomes a finite-size 'quantum core.'
- As mass falls in, both the horizon and the core radius increase.
- No singularity exists. Space cannot compress indefinitely.
- The final object is a quantum vacuum condensate, not a point of infinite density.

3.8 Final Fate of a Black Hole in DVFT

International Journal for Multidisciplinary Research (IJFMR) E-ISSN: 2582-2160 • Website: www.ijfmr.com • Email: editor@ijfmr.com IJFMR250664112 Volume 7, Issue 6, November-December 2025 28 Depending on parameters $(\rho_0, , a_0)$:

3.9 Stable quantum object: evaporation slows, horizon stalls, core remains.

3.10 Horizon shrinks until it meets the core, leaving a compact vacuum star.

3.11 Complete evaporation: horizon vanishes; core dissolves smoothly.

In all cases, there is no singularity and no information loss. Conclusion DVFT gives the first consistent picture of a black hole interior using a single phase field. It provides:

- GR-like exterior geometry,
- A finite-density quantum core replacing the singularity,
- A mechanism for black hole growth and evolution,
- A plausible resolution of the information paradox.

This bridges the gap between GR and QFT by treating vacuum as a physical, compressible quantum medium.

4 COSMOLOGY, BIG BANG, AND BIRTH OF THE UNIVERSE

This chapter presents a full cosmological formulation of the Dynamic Vacuum Field Theory(DVFT).

$UnderDVFT, theuniversedidnotbeginasasingularitybutasavacuum-phasetransitionfromanearzero$

$\Phi =$

ρ(x)e$^i\theta$(x). We show how DVFT naturally explains the Big Bang, inflation, cosmic expansion, dark energy, cosmic horizon problems, and other fundamental mysteries of cosmology.

4.1 Introduction

Traditional cosmological models built on General Relativity confront a fundamental problem: they begin with a singularity at t = 0 where curvature, density, and temperature diverge. This singularity eliminates the possibility of explaining the physical origin of the universe, inflation, or the emergence of space itself. DVFT replaces the singularity with a physically meaningful vacuum-phase defect, enabling a consistent explanation of how the Big Bang occurred, what existed before it, and why the universe expanded so rapidly.

4.2 The Vacuum Field in Cosmology

In cosmological symmetry, the vacuum field is homogeneous:

$\Phi(\mathrm{t}) = \rho(\mathrm{t})\ \mathrm{e}^i\theta(\mathrm{t})$

Here, ρ(t) is the vacuum amplitude determining vacuum energy density, and θ(t) encodes dynamic vacuum field. The vacuum Lagrangian contributes energy density:

$\epsilon_v ac = (d\rho/\mathrm{dt})^2{+}\rho^2(d\theta/\mathrm{dt})^2 + V(\rho)$

and pressure:

$p_v ac = (d$

$\rho/\mathrm{dt})^2{+}\rho^2(d\theta/\mathrm{dt})^2 - V(\rho)$

This becomes the source term in the Friedmann equations.

4.3 DVFT Friedmann Equations

The spacetime metric in a homogeneous universe is the FLRW form:

$$ds^2 = -dt^2 + a(t)^2[dr^2/(1-kr^2) + r^2 d$$

$\Omega^2]$ In DVFT, the Friedmann equations become:

$$(da/dt)^2/a^2 = (8$$

πG/3) $\epsilon_v ac$

$$d^2a/dt^2/a = -(4$$

πG/3)$(\epsilon_v ac + 3p_v ac)$ International Journal for Multidisciplinary Research (IJFMR) E-ISSN: 2582-2160 • Website: www.ijfmr.com • Email: editor@ijfmr.com IJFMR250664112 Volume 7, Issue 6, November-December 2025 29 The evolution of ρ(t) and θ(t) determines $\epsilon_v ac and p_v ac. Because the vacuum cannot diverge, \epsilon_v ac remains finite even at the earliest times.$

4.4 Pre-Big-Bang Vacuum Phase

Before the Big Bang, the vacuum field was in a near-zero amplitude state:

- ρ(t) ≈ 0
- θ(t) undefined or fluctuating

This state is energetically unstable. The vacuum potential:

$$V($$

$\rho) = \lambda\ (\rho^2 - \rho^2)^2$

$$encourages a phase transition toward the minimum at$$

$\rho = \rho.$

4.5 The Vacuum Phase Transition (Big Bang Event)

The Big Bang corresponds to the moment when the vacuum transitioned from the unstable state $\rho \approx 0$ to

$$the stable dynamic vacuum field state$$

$\rho = \rho.$ This transition releases energy, sets θ(t) into coherent

oscillation, and generates an explosive increase in $\epsilon_v ac. This triggers rapid expansion of the scale factor a(t$

4.6 Inflation from Dynamics

Inflation requires rapid acceleration of the universe. DVFT provides this because the vacuum-potential plateau makes V(ρ) nearly constant during the early evolution. During the transition: $\epsilon_v ac \approx$ constant Thus: (da/dt)/a $\approx$ constant exponential expansion DVFT inflation ends naturally when ρ(t) settles near ρ and θ(t) becomes coherent.

4.7 Reheating and Matter Creation

Once the vacuum field settles into coherent dynamic vacuum field, oscillations of Φ transfer energy into matter fields via interaction terms of the form:

$$L_i nt = -y|$$

$\Phi|$

This generates particle–antiparticle pairs, radiation, and thermal energy. The universe becomes radiation dominated.

4.8 Origin of Space Expansion

In GR, space expands, but no mechanism explains *why*. In DVFT, space expands because the vacuum amplitude ρ(t) increases and the dynamic vacuum field becomes coherent. Vacuum energy determines curvature, and a rapid change in vacuum energy produces rapid change in the scale factor.

4.9 Removal of the Cosmological Singularity

The divergence of curvature in GR arises because nothing limits density or curvature. In DVFT, dynamics impose:

- |dθ/dt| $\leq \theta_m ax\rho$(t) finite
- V(ρ) finite

- $\epsilon_v acfinite$ The energy density never diverges. The curvature invariants remain finite. The Big Bang is replaced by a finite, smooth vacuum phase transition. There is no singular point.

4.10 Horizon Problem Resolved

International Journal for Multidisciplinary Research (IJFMR) E-ISSN: 2582-2160 • Website: www.ijfmr.com • Email: editor@ijfmr.com IJFMR250664112 Volume 7, Issue 6, November-December 2025 30 The classical horizon problem asks why causally disconnected regions of the sky have the same temperature. In DVFT:

- Before the Big Bang, the vacuum was nearly homogeneous

- The vacuum phase transition occurred everywhere simultaneously
- Vacuum-phase waves propagate at c, enforcing coherence

No superluminal mechanisms needed.

4.11 Flatness Problem Resolved

The vacuum phase transition drives rapid inflation, which smooths curvature. This pushes the universe toward k = 0. Thus flatness arises automatically.

4.12 What Caused the Universe to Begin?

In DVFT, the universe begins because the vacuum was unstable in its low-amplitude configuration. When ρ reached the critical threshold, the vacuum rolled down its potential to ρ, initiating dynamic vacuum field and expansion. This is analogous to phase transitions in condensed-matter systems.

4.13 What Expanded During the Big Bang?

- Not matter.
- Not energy.
- Not space as pure geometry.

What expanded was:

- the vacuum amplitude $\rho(\mathrm{t})$.

As $\rho(\mathrm{t})$ increased, vacuum energy increased, forcing the metric to inflate. This is the physical meaning behind the expansion of space.

4.14 Dark Energy from Residual Dynamic vacuum field

Today, the vacuum still pulsates with frequency μ. If μ evolves slowly with time, or if the vacuum amplitude slightly shifts, this yields a small, nearly constant vacuum energy density. This naturally produces accelerated expansion of the universe without requiring a cosmological constant.

4.15 Full Evolution Summary

- Pre-Big-Bang: $\rho \approx 0$, incoherent vacuum
- Phase transition: ρ grows, θ becomes coherent
- Inflation: $V(\rho)$ nearly constant
- Reheating: Φ couples to matter
- Radiation era
- Matter era
- Dark energy era: residual dynamic vacuum field

Conclusion DVFT replaces the cosmological singularity with a physical vacuum-phase transition. It explains the origin of the universe, inflation, expansion, dark energy, and smoothness of the cosmos using a single vacuum field. This eliminates the inconsistencies of classical GR and provides a unified, microphysical picture of cosmology.

References and Notes

This document is part of the DVFT-T0 integration project. For complete details on T0 Theory, refer to the main T0 documentation. DVFT content is based on the work by Satish B. Thorwe, adapted to align with T0 Theory framework.

Key Adaptations

1. DVFT's vacuum field $\Phi(x) = \rho(x)e^{i\theta(x)}$ is derived from T0's $\Delta m(x, t)$
2. All DVFT parameters are expressed in terms of T0's ξ
3. Vacuum dynamics emerge from T0's time-mass duality
4. Field equations are grounded in T0's extended Lagrangian