Equilibration Cosmology: A Framework for a Unified Theory

Karl Archinal
9/6/2025
Revision 1.3

ABSTRACT. Foundational issues in modern cosmology, including the nature of dark energy and the existence of gravitational singularities, suggest the need for a new theoretical framework. This paper introduces Equilibration cosmology, a cosmological framework based on two core postulates: the universe is a closed system whose dynamics are governed by a fundamental disequilibrium between matter and antimatter, and a fourth spatial dimension with inversive geometric properties mediates this duality.

The model's cosmogenesis posits an initial event that established this fundamental matter-antimatter asymmetry. The subsequent evolution of the cosmos is attributed to a repulsive antigravity force, an emergent property of the system's drive toward equilibrium, which accounts for cosmic expansion without a dark energy component. The attractive force of gravity is described as a secondary effect of this primary repulsion.

Within this framework, particle properties such as mass are posited to be direct correlates of a particle's specific state of disequilibrium. This principle allows for a reinterpretation of the strong and weak nuclear forces as phenomena emergent from the geometry of the proposed 4th dimension. Quantum entanglement is consequently interpreted as a result of non-local connections through this higher-dimensional substrate.

The model thus offers a conceptually unified and self-consistent framework. This paper presents the full qualitative model and identifies key testable predictions to motivate the development of a corresponding mathematical formalism.

1. Introduction

The Standard Model of Particle Physics and the theory of General Relativity represent the twin pillars of modern physics, yet they leave several foundational questions unanswered. (1) A number of persistent anomalies and theoretical inconsistencies suggest that a more fundamental framework may be required. Specifically, three key challenges remain:[1]

- The physical nature of dark energy, a theoretical component required to explain the accelerated expansion of the cosmos.
- The existence of gravitational singularities, non-physical points of infinite density predicted at the center of black holes.
- The origin of baryon asymmetry.[2]

This paper introduces model of Equilibration cosmology, a cosmological framework that seeks to resolve these issues by positing a single, unifying mechanism (2): a universal progression toward a state of matter-antimatter equilibrium.

2. Core Postulates

The framework of the model is predicated on the following two fundamental postulates.

Postulate I, The Principle of Equilibrium

The universe is a closed system defined by a primordial disequilibrium between matter and antimatter domains. All physical laws and interactions are emergent phenomena governed by the system's thermodynamic progression toward a final, balanced state of perfect

[1] These challenges represent foundational limitations in the current cosmological perspective. Dark energy is a hypothesized form of energy required to explain observational data from Type Ia supernovae, indicating an accelerated expansion of the universe. Gravitational singularities are points where the solutions to the field equations of General Relativity predict infinite density and spacetime curvature, suggesting a breakdown of the theory. Baryon asymmetry refers to the observed imbalance between matter and antimatter, an asymmetry for which the Standard Model of particle physics offers no complete explanation.

[2] While the Standard Model of particle physics incorporates a mechanism for Charge-Parity violation—a necessary condition for baryogenesis—the amount of CP violation it predicts is insufficient to explain the observed cosmic asymmetry. The violation predicted was confirmed by experiments at SLAC and KEK, but it is orders of magnitude too small to account for the universe's matter-antimatter imbalance, leaving this a major unsolved problem in cosmology. (22)

equilibrium. This principle is asserted as the prime mover of all cosmic dynamics.[3]

Postulate II, The 4D Inversive Plane

A fourth spatial dimension with inversive geometric properties serves as the substrate for the matter-antimatter duality.[4] This plane is posited to be co-local with all points in 3D space, fundamentally separating the matter and antimatter domains while mediating their interaction.[5]

3. Cosmogenesis and Geometric Origins

The initial condition of the universe in the model is defined by a singular cosmogenic event that established both the structure of spacetime and the primordial disequilibrium.[6]

Symmetry Breaking from a Unified State

The model posits that the pre-inflationary universe existed in a state of perfect, undifferentiated equilibrium. The origin event is proposed to be a symmetry-breaking phase transition, analogous to the separation of forces in standard cosmology. [7] This event separated the unified state into the distinct domains of matter and antimatter, establishing the primordial disequilibrium that serves as the source of all cosmic energy and dynamics.[8] The fundamental forces and particle families are also considered products of this initial separation.

Postulated Spacetime Geometry

The model proposes a non-standard spatial geometry in which the coordinates of the universe are inverted relative to the origin event. This implies that cosmic expansion is not the propagation of matter into a pre-existing vacuum but is the continuous, structured unfolding of the spatial manifold itself from the initial event.[9]

4. Mathematical Formalism

To describe the dynamics of Equilibration Cosmology quantitatively, we introduce the following mathematical objects.

The Equilibrium Field (Φ_E)

The state of the universe is described by a fundamental scalar field, termed the Equilibrium Field (Φ_E). This field assigns a real number to every point in spacetime, representing that point's state of equilibrium. The value of the field is bounded, where:

- $\Phi_E = 0$ represents a state of perfect equilibrium (e.g., vacuum, photon).
- $0 < \Phi_E \leq +1$ represents the spectrum of the matter domain.
- $-1 \leq \Phi_E < 0$ represents the spectrum of the antimatter domain.

The Antigravity Field (Υ)

---

[3] This model also offers a novel resolution to the fine-tuning problem. While other theories propose solutions such as cosmological natural selection, which suggests the laws of physics may evolve over time (13), Equilibration cosmology posits that the observed structure of the universe is not a product of chance or evolution but is the necessary and inevitable consequence of a deterministic progression toward equilibrium.

[4] The author's conceptualization of a fourth spatial dimension was significantly influenced by the "fish in a pond" thought experiment, which illustrates how a lower-dimensional reality might perceive the effects of a higher dimension. This analogy was popularized by Michio Kaku in his work *Hyperspace*. (33)

[5] The postulation of an additional spatial dimension differs from most models, including the Kaluza-Klein theory of the 1920's, by proposing that the primary role of this dimension is to serve as the geometric substrate for the matter-antimatter duality. The concept of antimatter was first theoretically predicted by Paul Dirac in 1928 and experimentally confirmed with the discovery of the positron by Carl Anderson in 1932.

[6] This singular event is the model's analogue to the Big Bang. (18) The structured phase transition is asserted to have separated a prior state of perfect unity into the distinct domains of matter and antimatter, thereby establishing the primordial disequilibrium that serves as the engine for all subsequent cosmic evolution.

[7] In the Standard Model of Particle Physics, this refers to electroweak symmetry breaking. At the high energy levels of the early universe (above 100 GeV, approx. 10^{-12} seconds after the "Big Bang"), the electromagnetic and weak nuclear forces are theorized to have been unified into a single electroweak force. This symmetry was broken as the universe cooled, causing the forces to manifest separately. This concept is a cornerstone of the Glashow-Weinberg-Salam model, which was experimentally verified and awarded the Nobel Prize in Physics in 1979.

[8] In the standard model of cosmology, energy density is comprised of three distinct components. Based on data from the Planck mission, these are estimated to be approx. 68% dark energy, 27% dark matter, and 5% ordinary (baryonic) matter. The dynamics of the cosmos are governed by General Relativity. Equilibration cosmology proposes to replace this multi-component model with a single, unified source. (19)

[9] This concept is consistent with the standard model, described by the Friedmann–Lemaître–Robertson–Walker (FLRW) metric. The novel element proposed here is the inversive nature of this geometry. The mathematical principles of Inversive Geometry provide a formal basis for such a concept.

The primary force of the model is represented by a vector field, termed the Antigravity Field (Y). This force field is not fundamental but is derived from the gradient of the Equilibrium Field. The relationship is given by the equation.

$$\text{Y} = -k\nabla\Phi_E$$

Here, ∇ is the gradient operator, which describes the direction and magnitude of the fastest measured change in the Equilibrium Field. The constant k represents the intrinsic strength of the interaction, and the negative sign indicates that the force is repulsive, directed away from regions of high disequilibrium.

5. Explanatory Framework

The postulates and the proposed cosmogenesis of the model provide a coherent framework for reinterpreting a wide range of physical phenomena across multiple scales. (3)

Cosmological Dynamics

The model attributes the accelerated expansion of the universe to antigravity (henceforth referred to as Y), a fundamental repulsive force arising from the disequilibrium between the matter and antimatter planes.[10] This provides a physical mechanism for expansion, obviating the need for a dark energy component. The acceleration is proposed to be a natural consequence of the evolving cosmic geometry.[11]

Gravity as an Emergent Force

Gravitational attraction is re-framed as a secondary, emergent effect. Mass, as a localized concentration of disequilibrium, creates a tension on the 4D plane.[12] The universal repulsive force of antigravity (Y) creates a pressure gradient in this tension field, resulting in a net push that is perceived as attraction. This mechanism must reproduce all observed gravitational phenomena, including gravitational lensing. (4)

The Arrow of Time

The unidirectional flow of time is posited to be a direct consequence of the Principle of Equilibrium.[13] The model defines entropy as a measure of the system's proximity to equilibrium. Time's arrow is the perception of the universe's irreversible thermodynamic progression from its initial low-entropy state of disequilibrium toward a final, high-entropy state of balance.

Particle Physics and Quantum Mechanics

The pursuit of a unified framework that describes all particles and forces as emergent from a single principle has long been the ultimate goal of theoretical physics and related fields. This ambition was stated by Stephen Hawking:

> However, if we do discover a complete theory, it should in time be understandable in broad principle by everyone, not just a few scientists. Then we shall all, philosophers, scientists, and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason – for then we would know the mind of God. (5)

The concept of Equilibration cosmology provides a unified basis for both particle physics and quantum phenomena, asserting that all particles, fields, and forces are emergent properties of the "Spectrum of Equilibrium."

Massive Particles as Localized Disequilibrium

Fundamental particles with mass, such as quarks and leptons, are conceptualized as stable, localized points of disequilibrium. Their mass is the direct quantitative measure of this imbalance—the degree of tension or "wobble" they induce on the 4D plane. These particles derive their stability from existing in specific, quantized

---

[10] The gravitational behavior of antimatter is a significant unanswered question in experimental physics. While the overwhelming theoretical consensus assumes antimatter gravitates identically to matter, this has not yet been conclusively verified. Experiments at CERN, such as ALPHA-g, AEgIS, and GBAR, are currently attempting to make the first direct measurements of the Earth's gravitational field on antihydrogen atoms. Equilibration cosmology proposes a more fundamental, large-scale repulsion between matter and antimatter domains, of which the gravitational behavior of individual antiparticles would be a consequence. (23)

[11] The concept of a dynamic and evolving cosmic "geometry" is the foundation of cosmology. In the standard model, this evolution is mathematically described by the Friedmann equations. (24)

[12] This defines mass as an intrinsic property of a particle's state contrary to the intrinsically mass-less particles of the standard model. Instead, they acquire mass through their interaction with the Higgs field in a process known as the Higgs mechanism. A particle's mass is therefore determined by its degree of coupling to this field. (25)

[13] The link between probability and entropy that underpins this idea was pioneered by Ludwig Boltzmann. (26)

states of tension, analogous to stable, though imperfect, standing waves.[14]

Massless Particles as Dynamic Equilibrium

Massless bosons, such as the photon, are defined as propagating packets of perfect, dynamic equilibrium.[15] In a photon, the matter-antimatter duality is perfectly and continuously resolved. Its lack of rest mass is a direct consequence of this perfect internal balance. The model posits that its constant velocity, c, is the natural, unimpeded propagation speed for an entity in a state of perfect equilibrium through the fabric of spacetime.[16]
This provides a physical origin for the relationship between a photon's velocity (c), frequency (f), and wavelength (λ). Within the model, frequency (f) is the rate of the internal oscillation as the matter-antimatter aspects of the photon resolve, while wavelength (λ) is the physical distance in 3D space over which one complete cycle of this oscillation occurs. The formula $c = f\lambda$ thus becomes a fundamental property of the 4D plane: for an entity traveling at the constant speed of equilibrium (c), a more rapid internal oscillation (higher f) must necessarily complete its cycle over a shorter physical distance (shorter λ).[17]

Neutrinos as Tense, Near-Perfect Equilibrium

Neutrinos occupy a unique intermediate state and are crucial to understanding this spectrum. They are particles of tense, near-perfect equilibrium. Their exceptionally small mass is attributed to a miniscule and unstable disequilibrium. The phenomenon of neutrino oscillation is explained as the physical manifestation of this unstable state shifting between its three flavor configurations (electron, muon, tau) as the particle propagates, constantly attempting to settle into a more stable state of balance.[18] Their weak interaction with other matter is a direct result of their profound proximity to neutral, balanced state. (6)

Astrophysical Objects as Macroscopic Equilibrium States

The model scales this principle to macroscopic objects.

Neutron Stars

Neutron stars are regions of high-tension equilibrium, where immense gravitational pressure forces the matter and antimatter planes into a stable, non-annihilating resonance.[19]

Black Holes and Hawking Radiation

Black holes represent the ultimate end state of a perfect, static equilibrium where gravitational collapse is sufficient to fully resolve the matter-antimatter duality into a point of perfect balance, consistent with the model's redefinition of a singularity.[20] The model provides a new physical basis for Hawking Radiation, describing it as the thermodynamic interaction between a black hole's state of perfect equilibrium and the surrounding universe's state of disequilibrium.
In this framework, a black hole's event horizon is the boundary interface between the internal region of perfect equilibrium ($\Phi_E = 0$) and the external universe, which exists in a state of baseline disequilibrium. The vacuum of space, with its constant quantum fluctuations,

---

[14] The principle of quantization, in standard quantum mechanics, dictates that physical properties can only take on discrete values. Due to wave-particle duality, a bound particle is described as a standing wave, and only wavelengths that fit into a stable resonance are permitted. (39)

[15] In the standard model, a photon is the elementary particle that serves as the quantum of the EM field. It is the "prime mover" for the EM force, and its properties and interactions with charged matter are described by the theory of Quantum Electrodynamics (QED). (27)

[16] The observer-constant, **c**, is a foundational postulate and fundamental axiom of Einstein's Special Theory of Relativity (1905). Equilibration cosmology proposes a physical mechanism for this constancy, deriving it from the photon's nature as a state of perfect equilibrium. (28)

[17] Speed, frequency, and wavelength and the relationship between them is a property of all wave phenomena. The demonstration that light is an EM wave, and obeys this rule, was established by James Clerk Maxwell. His equations unified the theories of electricity, magnetism, and optics. (29)

[18] Experiments, notably the Super-Kamiokande in Japan and the Sudbury Neutrino Observatory in Canada, demonstrated that neutrinos change flavor as they travel, or "oscillate". This proved that neutrinos must have mass, which was a characteristic not originally accounted for in the standard model.

[19] Equilibration cosmology proposes that neutron degeneracy pressure is the macroscopic manifestation of the star's underlying state of high-tension equilibrium. In this view, the gravitational pressure forces the matter and antimatter planes into such close proximity that their mutual repulsion creates a stable, non-annihilating resonance, which is perceived as degeneracy pressure. (30)

[20] This stands in *direct* contrast to General Relativity's definition of a singularity. Roger Penrose demonstrated, through his singularity theorems, that within General Relativity, gravitational collapse inevitably leads to a point of infinite density and spacetime curvature where the known laws of physics break down. Equilibration cosmology proposes to resolve this physical infinity by defining the singularity not as a breakdown of physics, but as the ultimate state of physical equilibrium.

represents a low-level fluctuation of this disequilibrium field.

At the event horizon, the black hole's state of perfect balance will continuously interact with and "resolve" the disequilibrium of the vacuum just outside it. This process can be conceptualized as the black hole absorbing fluctuations of the disequilibrium field to maintain its internal state of perfect equilibrium. To conserve balance and remain at $\Phi_E = 0$, the black hole must then radiate away a corresponding amount of pure, balanced energy. This radiated energy is Hawking radiation. (7)

This continuous process of absorbing ambient disequilibrium and radiating away energy results in a slow loss of mass-energy of the black hole over cosmic timescales. This provides a deterministic, geometric explanation for the phenomenon, in contrast to the standard model, which relies on the probabilistic behavior of virtual particles at the event horizon.[21]

Fundamental Forces and Quantum Phenomena

The model's framework extends to the quantum realm, offering a physical reinterpretation of the strong and weak nuclear forces, the Higgs field, and the nature of entanglement itself. (8)

The Strong Force and Quark Confinement

The model posits that the strong nuclear force is not a distinct force mediated by gluons (9) but is the literal tension within the fabric of the 4D inversive plane. Quarks are conceptualized as stable, localized stress points in this plane. A hadron, such as a proton, represents a stable, three-point resonant configuration. The phenomenon of quark confinement is a direct consequence of this principle. Attempting to isolate a single quark is met with increasing tension at greater distances. At a critical point, the energy added to the system is converted into a new matter-antimatter pair, creating a new quark-antiquark pair and preventing the observation of an isolated quark.[22]

The Weak Force and Particle Decay

The weak nuclear force is re-framed as a secondary, emergent effect rather than a fundamental force. (10) It is proposed to be the quantum-scale manifestation of the antigravity field, analogous to a black hole's Hawking radiation. In this view, particle decay occurs when a particle in a less stable state of disequilibrium (a neutron) interacts with a quantum of this "antigravity radiation." This interaction provides the necessary impetus for the particle to transition to a more stable, lower-energy state of disequilibrium (a proton, electron, and antineutrino), thus providing a physical mechanism for why such decays occur.[23]

The Higgs Field its Relation to Disequilibrium

The model posits that the Higgs field is not a distinct, mass-giving entity, but is instead the scalar field that represents the baseline disequilibrium of the cosmos. The potential of this field is a direct function of the primordial tension between the matter and antimatter domains. A particle's mass, therefore, is not acquired via interaction, but is an intrinsic property corresponding to its own state of disequilibrium. This property dictates the degree of coupling between the particle and this universal tension field. The Higgs boson is the quantized, local excitation of this field. Its experimental detection is interpreted as a validation of the existence of this baseline disequilibrium.[24]

Quantum Entanglement as Higher-Dimensional Co-locality

The non-local connection between entangled particles is resolved by their posited co-locality in the 4th spatial dimension. In this view, the entangled particles are two 3D projections of a single, unified state vector. A measurement performed on one particle is a measurement of the entire state, with the outcome instantly reflected in the other projection without the violation of locality, as no signal propagates between them in 3D space. (11)

---

[21] Hawking radiation was groundbreaking for its synthesis of general relativity, quantum mechanics, and thermodynamics, and for suggesting that black holes are not entirely "black" but have a finite temperature and can evaporate over time.

[22] This geometric description can be contrasted with Quantum Chromodynamics. Equilibration cosmology reinterprets hadrons and gluons geometrically: stable hadrons are not seen as composites but as multi-point resonant configurations of the 4D plane itself, analogous to Chladni figures. (31) Gluons are re-conceptualized not as discrete particles but as quantized vibrations of the tension field within the plane, analogous to some of the concepts and principles of String Theory. (32) The QCD mechanism of confinement, where a "flux tube" of energy snaps to create a new quark-antiquark pair, is thereby explained as the conversion of applied energy into a new, stable resonance of the plane itself.

[23] The decay of a neutron is known as beta decay. In the standard model, this is a cornerstone example of an interaction mediated by the weak nuclear force. Equilibration cosmology proposes that the weak force is not a fundamental interaction but is the observable effect of the posited "

[24] In the standard model, the Higgs field and corresponding boson, was considered the final experimental validation of particle physics upon its 2012 discovery at CERN. (8)

Interaction	Sign of Φ_E	Resulting Force	Cosmological Role
Matter ↔ Antimatter	(+, -)	Primary Repulsion (Antigravity)	Drives Cosmic Expansion
Matter ↔ Matter	(+, +)	Secondary Attraction (Gravity)	Forms Galaxies, Stars, Planets, etc.
Antimatter ↔ Antimatter	(-, -)	Secondary Attraction (Gravity)	Forms Antimatter Structures

Figure 1

A Unified Mechanism for Cosmic Forces

The dynamics of Equilibration cosmology can be described by a single, fundamental scalar field, hereafter referred to as the Equilibrium Field (Φ_E). This field quantifies the state of equilibrium at any point in spacetime. The value of Φ_E defines a spectrum: perfect equilibrium is represented by $\Phi_E = 0$ (e.g., a vacuum or a photon), while the domain of matter is described by positive values ($0 < \Phi \leq 1$) and the domain of antimatter by negative values ($-1 \leq \Phi_E < 0$).

From the behavior of this field, a clear and unified mechanism for the universe's fundamental forces emerges, providing a single explanation for both large-scale cosmic expansion and local structure formation. The model yields two primary rules of interaction:

- Primary Repulsion (Antigravity): Regions of spacetime with opposite-signed Φ_E values exhibit a mutual, large-scale repulsion. This primary force is the mechanism for antigravity, driving the separation of the matter and antimatter domains and accounting for the observed accelerated expansion of the universe.
- Secondary Attraction (Gravity): Regions of spacetime with like-signed Φ_E values exhibit a secondary, emergent attraction. This force, perceived as gravity, is responsible for local structure formation within each respective domain (e.g., the clumping of matter to form galaxies, stars, and planets).[25] This mechanism must be consistent with and reproduce the observed phenomena of General Relativity.

The Origin of the Cosmic Web

A key observation in modern cosmology is that matter is not distributed uniformly, but is arranged in a vast, web-like structure of filaments, sheets, and clusters, interspersed with large voids.[26] (12) While the standard model explains this as the gravitational amplification of initial random quantum fluctuations, Equilibration cosmology posits that this structure is a direct and inevitable consequence of the universe's fundamental geometry.

The model's cosmogenesis proposes that the origin event established a set of radiating, foundational planes that define the structure of spacetime. These primordial planes form the underlying scaffold upon which matter later coalesced.

- Sheets and voids: The vast, sparsely populated voids are the regions far from these primordial planes, while the large sheets of galaxies correspond to matter that has collapsed along a single plane.
- Filaments: These bright, dense structures that connect the cosmic web are the result of matter collapsing along the linear intersections of two of these primordial planes.
- Clusters: The most massive and dense galaxy clusters are located at the nodal intersection of three or more of these primordial planes, representing the gravitational epicenters of the cosmic structure.

Therefore, the observed cosmic web is not an emergent property of random clumping, but rather a direct reflection of the deterministic, geometric structure established at the universe's origin.

6. Falsifiable Hypotheses

[25] In the standard model, structure formation is driven by gravity amplifying tiny, primordial density fluctuations from the early universe. It is suggested the initial seeds for structure were the geometric 'planes' established during cosmogenesis rather than random quantum fluctuations. (40)

[26] Observational evidence for this filamentary structure is extensive. The Las Campanas Redshift Survey has mapped these structures over hundreds of megaparsecs. The existence of this web is a primary feature that any viable cosmological model must explain.

The validity of the model can be ascertained through the following experimental and observational tests, each providing a clear avenue for falsification;

Hypothesis: Non-instantaneous Photon Reflection

- Prediction**:** The model predicts that a photon's reflection, as an interaction with the 4D inversive plane, is a process with a finite, non-zero duration.
- Experimental Signature**:** High-precision laser interferometry should detect a measurable propagation time delay in reflected photons that is inconsistent with the predictions of standard Quantum Electrodynamics.[27]

Hypothesis: A Variable Equation of State for Cosmic Expansion

Prediction**:** The model's "antigravity" force, which drives cosmic expansion, possesses a dynamic equation of state, unlike the cosmological constant (**Λ**).[28]
Experimental Signature**:** Precise measurements of the Hubble parameter at different cosmological epochs will reveal a deviation from the expansion history predicted by the standard model.

Hypothesis: Anisotropic Entanglement Correlation

Prediction**:** The model predicts that the correlation strength of entangled particles, being a function of their connection through the 4D plane, may exhibit a subtle anisotropy (directional dependence).
Experimental Signature**:** Ultra-precise entanglement experiments may detect a statistically significant directional dependence in correlation outcomes, potentially varying with orientation relative to major gravitational fields or cosmic structures.[29]

7. Conclusion and Future Work

Conclusion: A Framework for a Grand Unified Theory (GUT) or Theory of Everything (TOE)

One of the primary goals of modern theoretical physics is the development of a GUT that describes the electromagnetic, weak, and strong nuclear forces as different manifestations of a single, underlying interaction. Equilibration cosmology achieves this and extends further, offering a candidate framework for a Theory of Everything by also incorporating a mechanism for gravity.[30]
The model accomplishes this unification not through a new symmetry group, but by positing a single physical principle: the universal drive toward matter-antimatter equilibrium. Within this framework, the fundamental forces are re-contextualized as emergent phenomena derived from the dynamics of its two core postulates:

- **The Strong Nuclear Force:** The intrinsic tension within the 4D inversive plane. This tension explains the confinement of quarks, which are posited to be stable stress points in this higher-dimensional fabric.
- **The Weak Nuclear Force:** A secondary quantum effect of the primary antigravity field, providing a physical mechanism for particle decay as a transition toward more stable states of disequilibrium.
- **Electromagnetism:** It is mediated by photons, which are defined as propagating packets of perfect, dynamic equilibrium. In contrast, fundamental particles like neutrinos are states of tense, near-

[27] Quantum Electrodynamics (QED**)** is the relativistic quantum field theory of electromagnetism and is one of the most stringently tested and accurate theories in all of science. Proposing a deviation from its predictions is a significant claim. The high-precision laser interferometry required for such a test is technologically feasible, as demonstrated by the Laser Interferometer Gravitational-Wave Observatory (LIGO) experiment, which has achieved the sensitivity to detect gravitational waves. (38)

[28] The Hubble parameter (H_0) is the constant of proportionality in Hubble's Law, which describes the rate of the universe's expansion, first demonstrated by Edwin Hubble in 1929. The Cosmological Constant (Λ) is a term added by Albert Einstein to his theory of General Relativity to allow for a static universe. It is now used in the standard model to represent the energy density of the vacuum that drives accelerated expansion. (35) (36)

[29] Experiments testing the correlations between entangled particles have been central to validating the foundations of quantum mechanics. Bell's theorem (1964) provided the theoretical framework to experimentally test quantum mechanics against local hidden-variable theories. The pioneering work of physicists including Alain Aspect, John Clauser, and Anton Zeilinger has since confirmed the predictions of quantum mechanics with increasing precision: a body of work recognized with the 2022 Nobel Prize in Physics. The hypothesis presented here proposes a search for a novel, anisotropic effect within these established experimental frameworks. (37)

[30] A Grand Unified Theory (GUT) seeks to unify the strong, weak, and electromagnetic forces. A Theory of Everything (TOE) is a more ambitious framework that would also incorporate gravity. The most successful step toward this goal to date is the electroweak theory, which unified electromagnetism and the weak force and for which the 1979 Nobel Prize in Physics was awarded. (34)

perfect equilibrium, explaining their elusive nature and near-massless state.

- **Gravity:** The force is re-framed as an emergent, attractive force arising from a pressure-shadow effect. The universal repulsion of antigravity is shadowed between massive objects, resulting in a net push that is perceived as attraction. This mechanism culminates in black holes, which are not singularities but points of perfect, static equilibrium**.**

By deriving all four forces and the nature of key particles from a single, coherent narrative, the Equilibration cosmology presents a deeply interconnected and self-consistent picture of the cosmos.

Future Work

The Equilibration Model is presented herein as a qualitative and conceptual framework. While the preliminary mathematical objects of the theory have been established, the most critical step is the development of a complete, rigorous formalism to translate its postulates into a quantitative, predictive theory. The primary objectives of this future work include:

- Constructing a Lagrangian for the proposed Equilibrium Field (Φ_E). This is essential for deriving the field's equations of motion and its interaction with other fields.
- Developing the equation of state for the Antigravity Field ($\Upsilon = -k\nabla\Phi_E$). This must be done in a way that allows its predictions for the cosmic expansion rate to be tested against observational data from cosmology.
- Deriving a metric tensor that is a solution to the model's new field equations, ensuring that it is consistent with the observed phenomena of General Relativity in the appropriate limits.

This mathematical development is the essential bridge from the conceptual framework presented herein to a fully testable scientific theory.

8. References

1. Apollonio, A., & others. CERN. [Online] 09 31, 2023. https://home.cern/news/series/cern-answers/five-open-questions-fundamental-physics.

2. GUTFREUND, HANOCH, and JÜRGEN RENN. Ideas on Progress and Revolutions in Science. *The Einsteinian Revolution: The Historical Roots of His Breakthroughs.* s.l. : Princeton University Press, 2024, pp. 31-63. https://doi.org/10.2307/jj.3876688.5.

3. *Modern Cosmological Models.* Barrow, John D. 1978, Science Progress (1933-) 65, no. 257, pp. 129-60.

4. *Does antimatter fall up? A weighty CERN result is imminent.* Gibney, E. 2024, Nature, 633(8031),, pp. 740-741.

5. Hawking, Stephen. *A Brief History of Time: From the Big Bang to Black Holes.* s.l. : Bantam Books, 1988.

6. Thomson, Mark. *Modern Particle Physics.* s.l. : Cambridge University Press, 2013.

7. *Black Hole Explosions?* Hawking, S.W. 5443, s.l. : Nature, 1974, Vol. 248, pp. 30-31.

8. CERN. The Higgs Boson. [Online] CERN, 2023. [Cited: 09 07, 2025.] https://home.cern/science/physics/higgs-boson.

9. Office of Science. DOE Explains...Quantum Chromodynamics. [Online] US Department of Energy, 2025. [Cited: 09 07, 2025.] https://www.energy.gov/science/doe-explainsquantum-chromodynamics.

10. The Editors of Encyclopaedia Britannica. Weak Interaction. [Online] Encyclopedia Britannica, 07 28, 2023. [Cited: 09 07, 2025.] https://www.britannica.com/science/weak-force.

11. *Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?* Eins tein, Albert, Podolsky, Boris and Rosen, Nathan. 10, s.l. : Physical Review, 1935, Vol. 47, pp. 777-780.

12. *Large-Scale Structure in the Las Campanas Redshift Survey.* Best, J.S. 3, s.l. : Monthly Notices of the Royal Astronomical Society, 2000, Vol. 317, pp. 720-732.

13. Smolin, L. *Time Reborn: From the Crisis in Physics to the Future of the Universe.* s.l. : Houghton Mifflin Harcourt, 2013.

14. *On the problem of unity in physics.* Kaluza, T. 1921, Sitzungsberichte der Preussischen Akademie der Wissenschaften zu Berlin, pp. 966-972.

15. *Quantum theory and five-dimensional theory of relativity.* Klein, O. 1926, Zeitschrift für Physik, pp. 895-906.

16. *The quantum theory of the electron.* Dirac, P.A.M. 1928, Proceedings of the Royal Society A, 117 (778), pp. 610-624.

17. *The positive electron.* Anderson, C.D. 1933, Physical Review, 43 (6), pp. 491-494.

18. Overview - NASA Science. *NASA Science.* [Online] 2024. [Cited: 09 07, 2025.] https://science.nasa.gov/universe/overview/#big-bang.
19. ESA. Planck and the cosmic microwave background. [Online] 2018. https://www.esa.int/Science_Exploration/Space_Science/Planck.
20. *A homogeneous universe of constant mass and increasing radius accounting for the radial velocity of extra-galactic nebulae.* Lemaître, G. 1927, Annales de la Société Scientifique de Bruxelles, 47, pp. 49-59.
21. Weisstein, Eric W. Inversive Geometry. *Mathworld--A Wolfram Web Resource.* [Online] 2025. https://mathworld.wolfram.com/InversiveGeometry.html.
22. *Astrophysics in 2001.* Trimble, Virginia and Aschwanden, Markus J. May 2002, Publications of the Astronomical Society of the Pacific, Vol. 114, No. 795, pp. 475-528.
23. CERN. Antimatter-gravity experiments. [Online] 2024. [Cited: 09 07, 25.] https://home.cern/science/experiments/aegis.
24. Ryden, B. *Introduction to Cosmology.* s.l. : Cambridge University Press, 2017.
25. Fermilab Science. The Higgs boson. [Online] 2024. [Cited: 09 07, 2025.] https://www.fnal.gov/pub/science/particle-physics/higgs-boson.html.
26. Albert, D. The Thermodynamic Arrow of Time. [Online] 2022. [Cited: 09 07, 2025.] https://plato.stanford.edu/archives/win2022/entries/time-thermo/.
27. Feynman, Richard P. *QED: The Strange Theory of Light and Matter.* s.l. : Princeton University Press, 1985.
28. *On the Electrodynamics of Moving Bodies.* Einstein, Albert. 10, s.l. : Annelen der Physik, 1905, Vol. 322, pp. 891-921.
29. *A Dynamical Theory of the Electromagnetic Field.* Maxwell, James Clerk. London : Philosophical Transactions of the Royal Society of London, 1865, Vol. 155, pp. 459-512.
30. NASA. Neutron Stars. [Online] NASA Science, 2021. [Cited: 09 07, 2025.] https://science.nasa.gov/astrophysics/focus-areas/black-holes/neutron-stars.
31. Patterns in The Sand: A Mathematical Exploration of Chladni Patterns. [Online] 2000. [Cited: 09 07, 2025.] https://scholarscompass.vcu.edu/cgi/viewcontent.cgi?article=1098&context=jmsce_vamsc.
32. *STRING FIELD THEORY.* Kaku, Michio. 01, s.l. : International Journal of Modern Physics A, 1987, Vol. 02. https://doi.org/10.1142/S0217751X87000028.
33. Kaku, Michio. *Hyperspace: A Scientific Odyssey Through Parallel Universes, Time Warps, and the 10th Dimension.* New York : Oxford University Press, 1994.
34. Weinberg, Steven. *Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature.* New York : Pantheon Books, 1993.
35. *Cosmological Considerations in the General Theory of Relativity.* Einstein, Albert. s.l. : Sitzungsberichte der Preussischen Akademie der Wissenschaften, 1917, Vol. 1, pp. 142-152.
36. *A relation between distance and radial velocity among extra-galactic nebulae.* Hubble, Edwin. 3, s.l. : Proceedings of the National Academy of Sciences, 1929, Vol. 15, pp. 168-173.
37. The Nobel Prize Foundation. The Nobel Prize in Physics 2022. *NobelPrize.org.* [Online] 2022. [Cited: 09 07, 2028.] https://www.nobelprize.org/prizes/physics/2022/summary/.
38. —. The Nobel Prize in Physics 2017. *NobelPrize.org.* [Online] 2017. [Cited: 09 07, 2025.] https://www.nobelprize.org/prizes/physics/2017/summary/.
39. Feynman, Richard P., Leighton, Robert B., and Sands, Matthew. *The Feynman Lectures on Physics, Vol. III: Quantum Mechanics.* New York City : Basic Books, 2011.
40. NASA. How did the universe's first structures form? [Online] 2024. [Cited: 09 07, 2025.] https://science.nasa.gov/universe/early-universe/how-did-the-universes-first-structures-form/.