Hypothesis on the Fifth Dimension and Dark Light: A New Cosmological Model

Author: Karim Bourébi
16 rue Henri Pourrat
63190 Lezoux France
Independent researcher
karimboureb@outlook.fr
February 2024

Keywords: Cosmology - Dark Energy - Dark Matter - Fifth Dimension - Supposition - Hypothesis

Summary of the hypothesis:

The proposed hypothesis explores an interdisciplinary and innovative vision of cosmology, integrating notions of the fifth dimension, "dark light", and dynamic interactions between our universe and an anti-universe. This ambitious theory aims to unify and explain a variety of cosmological and quantum phenomena still unexplained by standard models, such as the accelerated expansion of the universe, the nature and properties of dark energy and dark matter, as well as the principles of quantum superposition and entanglement.

At the heart of this hypothesis is the idea of a fifth dimension that transcends the known four-dimensional space-time, acting as a mediator not only between the visible universe and a potential anti-universe but also as a source of the mysterious "dark light", conceptualized here as a form of dark energy. This additional dimension would offer a new framework for understanding the fundamental interactions of nature, proposing that the forces and phenomena observed in our universe could be influenced or directly derived from this omnipresent dimension.

The goal of this hypothesis is to lay the foundation for a unified theory that could potentially fill gaps in current theories by providing new insights into the structure and dynamics of the universe, while paving the way for technological advances revolutionaries in communications, space propulsion, energy generation, and beyond. By envisioning a complex and multidimensional interaction between visible light, dark light, and fundamental forces across a fifth dimension, this theory aspires to revolutionize our understanding of the universe, its formation, its expansion, and the fundamental laws that govern it.

Table des matières

Foreword

Light!

What is the origin of this phenomenon that has fascinated mankind since the dawn of time and which still remains a mystery to be discovered today, despite the knowledge we have acquired through years of evolution, allowing us to advance technologically through a better understanding of the environment that encompasses us in the universe to which we belong.

Light is still a mystery that we seek to explain by various hypotheses that have crossed different eras since the observation of the first astronomers through the beginnings of modern physics enabled by the equations of James Maxwell who was the first to determine a constant value to light for having studied the phenomenon of electromagnetism discovered by Faraday in 1822. Since then, light has joined the relativistic principle expressed by the mathematician Henri Point Carré, which led to the development of the theory of relativity by Albert Einstein.

However, despite the discovery of numerical values that provide solutions to the equation, light has still not found an explanation of its origin, and can only be described by relative measurements that do not explain the cause of the phenomenon or the origin of its nature.

Current science is confronted with numerous contradictions between the quantum world and the relativistic world, despite the reality measured by human observation. Light is, however, a reality that exists in the universe as a whole, making it impossible to have no correlation between the different fields of physics to define light as the cornerstone that is the common point for linking the fundamental interactions of the universe in order to establish a universal theory of unified fields that has been impossible until now. Despite the contradictions encountered, the opposite remains impossible, allowing us to deduce that certain errors, probably due to a lack of understanding, are certainly at the origin of this incoherence, despite the accuracy of the results obtained, which define our reality.

Based on this principle, we can conclude that light is the origin of a conflict that poses a problem to become the only solution that responds to the problem posed. This forces us to question our knowledge of light in order to discover an as yet unknown correspondence that will become a common bridge to scientific knowledge in order to overcome the limits of human understanding.

The hypothesis that follows takes account of relativistic and quantum observations on the study of light without contradicting the verified principles that define our scientific laws enabled by their equation relationship.

This hypothesis integrates new concepts such as dark light, a fifth dimension and an anti-universe.

It is necessary to specify that being neither physicist nor belonging to any scientific field, this reasoning was established in a self-taught way.

Any contribution to solve these equations (very complex for some) will be welcome.

Welcome to the fifth dimension!

The Speed and Omnipresent Field:

In this hypothesis, we consider light as an omnipresent field in which photons move at the speed of light (299,792.458 km/s) within this field.

To assert that light does not move, but rather constitutes an omnipresent field, while simultaneously acknowledging the constancy of the speed of light (c=299,792,458 m/s) in a vacuum, appears at first glance contradictory according to the principles of conventional physics. However, this idea can be explored within a specific conceptual framework that reconciles these two aspects under certain conditions. Here is how this could be envisioned:

Omnipresent Field Concept

The notion that light represents an omnipresent field could be interpreted through the prism of quantum field theory, where fields are not simply seen as empty spaces but as being filled with the potential for the existence of particles. In this context, the electromagnetic field is everywhere, and photons (the quanta of light) are excitations of this field. This does not mean that light "does not move" in the literal sense, but rather that the potential for light (or electromagnetic energy) exists everywhere in space.

The Speed of Light

The constancy of the speed of light is an empirical observation and a fundamental postulate of special relativity. When it is said that light has a constant speed, it refers to the speed at which the excitations of the electromagnetic field (photons) propagate through the vacuum. This characteristic is measurable and has been confirmed by numerous experiments.

Potential Compatibility

In a sense, it is thus possible to conceive a framework where light is both an omnipresent field (the electromagnetic field that exists everywhere and at all times) and something that propagates at a constant speed (photons moving through this

field). Omnipresence refers to the ubiquity of the electromagnetic field, while the constant speed describes the behavior of the excitations (photons) within this field.

Challenges in Conceptualization

However, this idea poses significant challenges in terms of conceptualization and interpretation within the framework of current physics. It requires a clear distinction between the ubiquitous presence of the electromagnetic field (as a state of potential) and the dynamic behavior of photons (as particles or waves propagating through this field).

To conceptualize the phenomenon where light is both considered as an omnipresent field and having a constant propagation speed, one can draw inspiration from quantum field theory (QFT). In this framework, the following equation could be proposed to illustrate this duality:

$$\Psi(x,t) = \int \frac{d^3p}{(2\pi)^3} \frac{1}{\sqrt{2\omega_p}} \left(a_p e^{-i(px-\omega_p t)} + a_p^\dagger e^{i(px-\omega_p t)} \right)$$

\Psi(x, t) = \int \frac{d^3p}{(2\pi)^3} \frac{1}{\sqrt{2\omega_p}} \left(a_p e^{-i(px - \omega_p t)} + a_p^\dagger e^{i(px - \omega_p t)} \right)

where:

- Ψ(x,t) represents the electromagnetic field at position x and time t,

- p is the momentum vector of the photon,

- ωp=c|p| is the angular frequency of the photon, with c being the speed of light,

- ap and ap† are the annihilation and creation operators for photons, respectively,

- x and t are the space and time variables.

This equation describes the electromagnetic field as a superposition of plane waves (photons) with different momenta, representing the omnipresence of the electromagnetic field in spacetime. The exponential part describes the propagation of these plane waves through spacetime at the speed of light c, highlighting the constancy of the speed of light for these field excitations.

Interpretation:

- Omnipresent Field: The integral over all possible momenta (d^3p) reflects the concept that the electromagnetic field (and thus the potential for light) is omnipresent in spacetime. Each term in the integral represents a possible plane wave component

of the electromagnetic field, suggesting that the electromagnetic field has an omnipresent potential to generate photons everywhere in space.

- Constant Propagation Speed: The temporal and spatial dependence in the exponential terms (e−i(px−ωpt) and ei(px−ωpt)) illustrates the propagation of the field excitations (photons) through spacetime at a constant speed c. This propagation is governed by the dispersion relation for photons, where the angular frequency ωp is directly proportional to the momentum p and the speed of light c.

Conclusion: This equation, while being a simplification, serves to conceptually illustrate how light can be both viewed as an omnipresent field (the electromagnetic field existing everywhere and at all times) and as having a constant propagation speed (photons moving through this field).

If we conceive light as an omnipresent electromagnetic field in which matter moves, this idea suggests an interpretation where matter particles continuously interact with the surrounding electromagnetic field. This interaction can be conceptualized in terms of quantum field theory, where matter particles, such as electrons and quarks, exchange photons (the quanta of the electromagnetic field) when they interact. Here is how this idea could be formulated using the formalism of quantum field theory:

In the interaction Lagrangian equation:

$$\mathcal{L}_{\text{int}} = -q\bar{\psi}\gamma^\mu\psi A_\mu$$

\mathcal{L}_{\text{int}} = -q \bar{\psi} \gamma^\mu \psi A_\mu

we find the following components:

- \(\mathcal{L}_{\text{int}} \) is the Lagrangian describing the interaction between matter (charged particles) and the electromagnetic field.

- \(q \) represents the electric charge of the particle.

- \(\bar{\psi} \) and \(\psi \) are the Dirac fields representing matter particles (for example, electrons) and their antiparticles. These fields obey the Dirac equation and describe the quantum properties of the particles, including their spin.

- \(\gamma^\mu \) are the Dirac gamma matrices, which are used in the formulation of the Dirac equation in quantum field theory. They are used to manipulate the spin properties of particles in Minkowski spacetime.

- \(A_\mu \) is the vector potential of the electromagnetic field, representing the omnipresent light field in this discussion. Photons are the quantum excitations of this field.

This equation illustrates how matter interacts with the electromagnetic field: through the exchange of photons, which are the mediators of the electromagnetic force. In this framework, matter particles move and interact in an omnipresent light field, which alters their trajectories and energy states.

This conceptualization provides a basis for understanding phenomena such as the scattering of light by matter, the absorption and emission of photons by atoms, and the electromagnetic forces that operate between charged particles. It highlights the fundamental nature of the interaction between light (the electromagnetic field) and matter in the universe, in accordance with the principles of quantum physics and quantum electrodynamics.

In this hypothesis, we are integrating the concept of dark light—a light found in a negative state, filling the dark universe in a 5th dimension (omnipresent field) where time becomes simply an infinite present and where light is already present everywhere at the same instant.

$$f(x, y, z, d) = C_1 \left(\frac{\exp(-d) \sin(x) \cos(y) \exp(-z))}{1 + d^2} + \frac{\exp(d) \cos(x) \sin(y) \exp(-z))}{1 + d^2} \right)$$

Equation en latex : F(x, y, z, d) = \frac{c_1 \left(\exp(-d) \sin(x) \cos(y) \exp(-2) \right)}{1 + d^2} + \frac{\exp(d) \cos(x) \sin(y) \exp(-z)}{1 + d^2}

The fifth dimension is described by a function 'f' of three familiar spatial variables: x, y, z, while the fourth variable 'd' represents the additional dimension, also taking into account the positive and negative pressure of light, assuming it has two aspects, one radiant with a + sign and the other dark (space void) with a - sign.

To define the concept that dark light and visible light propagate in the same omnipresent field, taking into account the potential interaction between these two types of light through the fifth dimension, one can consider a mathematical formulation that captures this interaction and propagation. Here is an equation that attempts to formalize this idea:

$$\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} - \frac{1}{4} G_{\mu\nu} G^{\mu\nu} + (\partial_\mu \Phi)^\dagger (\partial^\mu \Phi) + (\partial_\mu \Psi)^\dagger (\partial^\mu \Psi) - V(\Phi, \Psi)$$

\mathcal{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} -\frac{1}{4}G_{\mu\nu}G^{\mu\nu} + \left(\partial_\mu \Phi \right)^\dagger \left(\partial^\mu \Phi \right) + \left(\partial_\mu \Psi \right)^\dagger \left(\partial^\mu \Psi \right) - V(\Phi, \Psi)

- \(F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu \) is the electromagnetic field tensor for visible light, with \(A_\mu \) representing the vector potential of visible light.

- \(G_{\mu\nu} = \partial_\mu B_\nu - \partial_\nu B_\mu \) is a similar tensor for dark light, where \(B_\mu \) is the vector potential for dark light.

- \(\Phi \) represents the scalar field associated with visible light, and \(\Psi \) is the scalar field for dark light.

- \(V(\Phi, \Psi) \) is a potential that describes the interaction between visible light and dark light.

- The terms \((\partial_\mu \Phi)^\dagger (\partial^\mu \Phi) \) and \((\partial_\mu \Psi)^\dagger (\partial^\mu \Psi) \) describe the propagation of the scalar fields of visible and dark light, respectively.

This equation attempts to model the dynamics of the fields of visible and dark light, as well as their potential interactions, within the framework of a unified field theory. It illustrates how these two forms of light may coexist and interact within the same omnipresent field, potentially through or with the influence of a fifth dimension.

Link between electromagnetic and gravitational forces:

Below is an equation that unifies electromagnetic and gravitational forces by adding an extra dimension. It describes the interaction between electromagnetic fields and gauge bosons in this five-dimensional space, where the photon is represented by the wave function 'Psi'. The value of the coupling parameter 'lambda' affects the strength with which the electromagnetic field propagates into the fifth dimension.

$$F_{mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu + i\bar{\psi}\gamma^\mu\partial_\nu\psi - i\bar{\psi}\gamma^\nu\partial_\mu\psi - \lambda A_\mu A_\nu$$

F_{mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu + i\bar{\psi}\gamma^\mu\partial_\nu\psi - i\bar{\psi}\gamma^\nu\partial_\mu\psi - \lambda A_\mu A_\nu

F_{mu\nu} represents the electromagnetic tensor.

A_\mu is the electromagnetic potential vector.

psi is the wave function for the photon in a five-dimensional space.

i\bar{\psi}\gamma^\mu\partial_\nu\psi and -i\bar{\psi}\gamma^\nu\partial_\mu\psi represent the interaction of photons with the electromagnetic field in the fifth dimension, where \gamma^\mu are the Dirac matrices.

The symbols \partial_\mu and \partial_\nu denote the partial derivatives with respect to the spatial and temporal coordinates of the four-dimensional spacetime.

The constant \lambda is a coupling parameter linking the electromagnetic field to the fifth dimension. This constant can be considered as a measure of the strength with which the electromagnetic field propagates into the fifth dimension.

A simplified formulation of such a unified theory might look like this, using the notation of field theory:

$$S = \int d^4x \sqrt{-g} \left(\frac{R}{16\pi G} + \mathcal{L}_{\text{EM}} \right) + \int d^5x \sqrt{-g^{(5)}} \mathcal{L}_{\text{5D}}$$

S = \int d^4x \sqrt{-g} \left(\frac{R}{16\pi G} + \mathcal{L}_{\text{EM}} \right) + \int d^5x \sqrt{-g^{(5)}} \mathcal{L}_{\text{5D}}

S is the total action of the system.

∫d^4x \sqrt{-g} represents the integral over four-dimensional spacetime.

R is the Ricci scalar, representing the curvature of spacetime due to the presence of mass-energy.

G is Newton's gravitational constant.

\mathcal{L}_{\text{EM}} is the electromagnetic Lagrangian, describing the electric and magnetic fields.

∫d^5x \sqrt{-g^{(5)}} \mathcal{L}_{\text{5D}} adds a contribution from a five-dimensional theory, where g^{(5)} is the determinant of the metric tensor in this extended space, and \mathcal{L}_{\text{5D}} is a Lagrangian that could describe fields or phenomena that exist only in this additional dimension.

To integrate the role of dark light into a unified equation that combines gravity and electromagnetism, while taking into account an additional dimension, we can consider adding a specific term to the Lagrangian that describes the dynamics of dark light and its interaction with gravitational and electromagnetic fields. Here is how this integration could be conceptualized:

$$S = \int d^4x \sqrt{-g} \left(\frac{R}{16\pi G} + \mathcal{L}_{\text{EM}} + \mathcal{L}_{\text{dark light}} \right) + \int d^5x \sqrt{-g^{(5)}} (\mathcal{L}_{\text{5D}} + \mathcal{L}_{\text{5D, dark light}})$$

$$S = \int d^4x \sqrt{-g} \left(\frac{R}{16\pi G} + \mathcal{L}_{\text{EM}} + \mathcal{L}_{\text{dark light}} \right) + \int d^5x \sqrt{-g^{(5)}} (\mathcal{L}_{\text{5D}} + \mathcal{L}_{\text{5D, dark light}})$$

$\mathcal{L}_{\text{dark light}}$ represents the Lagrangian of dark light in four-dimensional spacetime, which describes the properties and dynamics of dark light, as well as its interaction with ordinary matter and electromagnetic fields.

$\mathcal{L}_{\text{5D, dark light}}$ is the Lagrangian that specifically describes the dynamics of dark light in the fifth dimension and its interactions with other fields present in this additional dimension.

The addition of these terms allows us to explore how dark light, conceptualized as a form of energy or a field that traverses both our four-dimensional universe and the additional fifth dimension, influences gravity and electromagnetism. This approach could offer a framework for studying the effects of dark light on cosmic expansion, the curvature of spacetime, and other physical phenomena.

For dark light to play a key role in the interaction between gravity and electromagnetism, by adding the dimension of dark light to our unified equation, we must consider its unique properties and potential influence on these fundamental forces. Dark light, as a component of dark energy or as a separate entity influencing the dynamics of the universe, could alter the way we understand the interaction of fields across spacetime and the fifth dimension. Here are some key aspects of its potential role:

Modulation of Gravity and Electromagnetism: Dark light could modulate the strength of gravity and electromagnetism across spacetime, depending on its distribution and intensity. This could manifest as variations in the fine-structure constant or in the perceived gravitational constant in different regions of the universe.

Propagation through the Fifth Dimension: If dark light can freely propagate through the fifth dimension, it could serve as a mechanism of interaction between our universe and other parallel realities or dimensions, potentially influencing matter and energy in ways that are not obvious in the four-dimensional framework.

Influence on the Expansion of the Universe: Dark light could be a major source of the acceleration of the universe's expansion, acting as a form of dark energy. Its dynamics in the fifth dimension could provide clues about the nature of dark energy and its contribution to cosmology.

To formalize these ideas, we could consider an extension of the Lagrangian that specifically includes interaction terms between dark light, gravity, and electromagnetism, accounting for propagation in the fifth dimension:

$$\mathcal{L}_{\text{interaction}} = \kappa(\mathcal{L}_{\text{EM}} \cdot \mathcal{L}_{\text{dark light}} + \mathcal{L}_{\text{grav}} \cdot \mathcal{L}_{\text{dark light}}) + \xi\mathcal{L}_{\text{5D, dark light}}$$

$$\mathcal{L}_{\text{interaction}} = \kappa (\mathcal{L}_{\text{EM}} \cdot \mathcal{L}_{\text{dark light}} + \mathcal{L}_{\text{grav}} \cdot \mathcal{L}_{\text{dark light}}) + \xi \mathcal{L}_{\text{5D, dark light}}$$

κ and ξ are coupling constants that determine the strength of the interaction between dark light and electromagnetic and gravitational fields, both in our four-dimensional spacetime and in the fifth dimension.

These interaction terms would allow us to study how dark light influences gravitational phenomena and electromagnetic interactions, potentially leading to observable consequences such as anomalies in gravitational lensing, variations in electromagnetic field propagation, or unexplained cosmic events.

In this theoretical framework, the influence of dark light on fundamental forces may not be limited to additive effects; it could involve complex dynamics where dark light interacts with the fabric of spacetime itself, possibly leading to the emergence of novel phenomena or the modification of existing laws of physics.

The proposed unified theory, which now incorporates dark light, could be instrumental in explaining several astrophysical observations that currently challenge our understanding of physics, such as the behavior of galaxies and galactic clusters, discrepancies in the cosmic microwave background radiation, and the puzzling observations of high-energy cosmic rays.

Moreover, the theoretical exploration of dark light within this unified model may offer insights into the nature of dark matter. If dark light interacts with dark matter in the fifth dimension, it could reveal hidden aspects of dark matter's distribution and properties, and explain why dark matter has been so elusive in direct detection experiments.

In summary, the integration of dark light into a unified theory of electromagnetism and gravity, extended by an extra dimension, presents a rich field of study with the potential to advance our understanding of the universe. It encourages the development of novel experiments and observations to test the predictions of such a theory, and could lead to groundbreaking discoveries in the realms of particle physics, cosmology, and beyond.

Electromagnetic Fields:

Below is an equation that underscores the fundamental importance of electromagnetic fields and their propagation as the underlying mechanism not only for visible light but also for the entire electromagnetic spectrum. This serves as a reminder that light is a particular case of the electromagnetic phenomenon, and that the ubiquitous electromagnetic fields serve as the medium for the propagation of electromagnetic waves through space:

$E(x,t) = (1/4\pi\varepsilon_o) \iiint [p(x',t')/r^2] + [(1/c)^2 \partial^2/\partial t^2 (j(x',t'/r)] \, dv'$

\[E(x,t) = \frac{1}{4\pi\epsilon_0} \iiint \left[\frac{p(x',t')}{r^2}\right] + \left[\frac{1}{c^2} \frac{\partial^2}{\partial t^2}\left(\frac{j(x',t')}{r}\right)\right] dv' \]

\(E(x,t) \) is the electromagnetic field at a point \(x \) and at a moment \(t \) in space, resulting from a distribution of charges \(p(x',t') \) and currents \(J(x',t') \) at a previous moment \(t' \) in space. Where \(r \) is the distance between the source point of the charges and the point where the field is measured, \(\epsilon_0 \) is the permittivity of free space, \(c \) is the speed of light, and \(dv' \) is a volume element.

Imagine that the universe is filled with dark light, invisible and undetectable. A potential energy of negative sign (dark light) as opposed to visible and measurable radiation.

$$E(x) = \psi_+(x) \cdot \psi_-(x) - \frac{1}{4\pi} \oint_\phi \psi_+(x') \cdot \psi_-^*(x') dx'$$

LaTeX Equation:

\[E(x) = \psi_{+}(x) \cdot \psi_{-}(x) - \frac{1}{4\pi}\oint_{\phi} \psi_{+}(x')\cdot \psi_{-}^*(x')dx' \]

\(E(x) \) represents the energy or another effect resulting from the interaction between visible light \(\psi_{+}(x) \) and "dark light" \(\psi_{-}(x) \) at point \(x \).

- Local interaction \(\psi_{+}(x) \cdot \psi_{-}(x) \): This interaction could represent the immediate influence of the two forms of light on each other. In this hypothesis, this local interaction could symbolize how visible light and dark light (or dark energy) combine or influence each other in space.

- Global interaction \(-\frac{1}{4\pi} \oint_{\phi} \psi_{+}(x') \cdot \psi_{-}^*(x')dx' \): This part, representing integration over a surface, suggests a broader interaction that extends over a certain region of space. In this hypothesis, it could represent the cumulative effect of the interaction between visible light and dark light on a large scale, potentially contributing to the expansion of the universe.

The sum of the total light (positive and negative) would be expressed as follows:

$$I_{totale} = I_{+}I_{-}$$

\[I_{\text{total}} = I_+ + I_- \]

To give physical meaning to this equation in the context of the universe, one might consider that visible light (\(I_+ \)) represents the measurable and observable energy or radiative contributions, such as starlight, cosmic background radiation, etc. On the other hand, dark light (\(I_- \)) could represent a hypothetical form of energy or radiation that has an opposite or complementary effect, perhaps analogous to dark energy or dark matter in terms of gravitational or cosmological effects, but remains undetected by traditional instruments.

The darkness of the universe would be a presence of negative sign (-) light that could be akin to dark energy, which remains a mystery to science.

$$E_{\text{obscurité}} = \rho_{\text{énergie sombre}}$$

\[E_{\text{darkness}} = \rho_{\text{dark energy}} \]

- \(E_{\text{darkness}} \) is the energy of the "dark light".

- \(\rho_{\text{dark energy}} \) is the dark energy density in the universe

It indicates that the energy associated with the "darkness" or "dark light" in the universe is equivalent to the density of dark energy (\(\rho_{\text{dark energy}} \)).

- Dark energy: In the standard cosmological model, dark energy is a form of energy that fills space uniformly, exerting a negative pressure, leading to the acceleration of the expansion of the universe. It is characterized by its energy density, \(\rho_{\text{dark energy}} \), and is often associated with the cosmological constant \(\Lambda \) in Einstein's equations of general relativity.

- "Dark light": The concept of "dark light" as being energy with a "negative sign" is an interesting metaphor for discussing dark energy. This idea suggests an approach where dark energy is not simply considered a repulsive force or a cosmological constant but perhaps as something that can be conceptualized in a more dynamic or interactive manner with the matter and visible energy of the universe.

Attempt to Introduce the 5th Dimension to General Relativity:

$$R^{ab} - \frac{1}{2}Rg^{ab} = T^{ab} + \lambda g^{ab} + \frac{8\pi G}{c^4}\left(T^{\phi}_{\phi} - T^{\chi}_{\chi}\right)g^{ab}$$

LaTeX Equation: \(R^{ab} - \frac{1}{2} R g^{ab} = T^{ab} + \lambda g^{ab} + \frac{8 \pi G}{c^4} \left(T^{\phi}_{\ \phi} - T^{\chi}_{\ \chi} \right) g^{ab} \)

This is an extended version of the Einstein equation to describe the distribution of matter, energy, and light in the 5 dimensions interacting with the curvature of spacetime. The extension on the right represents the energy-momentum tensors associated with these fields and \(g^{ab} \) is the metric with an additional fifth dimension.

$$G^{(5)}_{\mu\nu} + \Lambda g^{(5)}_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu} + K^{(5)}_{\mu\nu}$$

LaTeX Equation: \(G_{\mu\nu}^{(5)} + \Lambda g_{\mu\nu}^{(5)} = \frac{8\pi G}{c^4} T_{\mu\nu} + K_{\mu\nu}^{(5)} \)

\(G_{\mu\nu}^{(5)} \) and \(g_{\mu\nu}^{(5)} \) are generalizations of the Einstein tensor and the metric tensor to five dimensions.

\(c \) is the speed of light.

\(T_{\mu\nu} \) is still the energy-momentum tensor but could also be modified to reflect the influences of the fifth dimension or other factors.

\(K_{\mu\nu}^{(5)} \) is an additional term representing extra effects due to the fifth dimension or other modifications to the theory.

Energy-Momentum Tensor in 5 Dimensions:

$$T^{ab} = \begin{pmatrix} \rho & S_1 & S_2 & S_3 & 0 \\ S_1 & P_{11} & P_{12} & P_{13} & 0 \\ S_2 & P_{21} & P_{22} & P_{23} & 0 \\ S_3 & P_{31} & P_{32} & P_{33} & 0 \\ 0 & 0 & 0 & 0 & \sigma \end{pmatrix}$$

T^{ab} = \begin{pmatrix}

\rho & S_1 & S_2 & S_3 & 0 \\

S_1 & P_{11} & P_{12} & P_{13} & 0 \\

S_2 & P_{21} & P_{22} & P_{23} & 0 \\

S_3 & P_{31} & P_{32} & P_{33} & 0 \\

0 & 0 & 0 & 0 & \sigma\end{pmatrix}

\(\rho \) represents energy density in the standard four dimensions (three spatial, one temporal).

\(S_i \) (where \(i=1,2,3 \)) are the energy fluxes in the three spatial dimensions.

\(P_{ij} \) are the pressures or stresses in the three spatial dimensions.

The zeros in the last row and column indicate that there is no energy flow or momentum associated with the fifth dimension, which is consistent with the description of a static light and an absence of temporal dynamics in this dimension.

\(\sigma \) is a term specific to the fifth dimension. Since this dimension has unique properties according to this hypothesis, this term could represent a form of "static energy density" or another physical characteristic specific to this dimension.

This energy-momentum tensor is adapted to reflect the unique characteristics of the fifth dimension as described. It differs from traditional formulations in that it does not allow for energy or momentum exchanges with or within the fifth dimension, due to its static nature and the absence of a temporal component.

5-Dimensional Metric Tensor:

$$\begin{pmatrix} -1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

\begin{pmatrix}

-1 & 0 & 0 & 0 & 0 \\

0 & 1 & 0 & 0 & 0 \\

0 & 0 & 1 & 0 & 0 \\

0 & 0 & 0 & 1 & 0 \\

0 & 0 & 0 & 0 & 0

\end{pmatrix}

In this matrix:

- The first row and column (-1) represent the temporal dimension.

- The 1's on the diagonal represent the three spatial dimensions.

- The fifth row and column (0) represent your unique fifth dimension. The zero in this dimension suggests that this dimension does not have a dynamic component in the way it is measured or perceived, in line with your description of a dimension where light is static and events are superimposed.

Cosmological Constant and Dark Light:

The idea that the cosmological constant could represent a concept such as "dark light" is intriguing and warrants exploration within the framework of theoretical physics.

The cosmological constant \(\Lambda \) in Einstein's general relativity is traditionally interpreted as a measure of the vacuum energy or the energy density of space itself. It plays a key role in current cosmological models, especially regarding the explanation of the acceleration of the universe's expansion, often attributed to dark energy.

If we consider linking the cosmological constant to "dark light" under this hypothesis, it could imply several things:

1. **Vacuum Energy:** "Dark light" could be a form of vacuum energy, acting similarly to the dark energy currently considered to explain the accelerated expansion of the universe.

2. **Influence on the Geometry of Space-Time:** As the cosmological constant affects the overall curvature of space-time, "dark light" could have a similar effect, potentially influencing the large-scale structure of the universe.

3. **Properties of Light:** If "dark light" is an unknown form of light, it might suggest light or radiation properties that do not interact conventionally with matter, similar to how dark energy does not seem to interact with baryonic matter.

4. **Role in the Fifth Dimension:** In relation to this hypothesis, if "dark light" is tied to a fifth dimension, then the cosmological constant could also be a manifestation of this additional dimension and its influence on our four-dimensional space-time.

5. **Cosmological Implications:** If "dark light" and the cosmological constant are connected, it could have profound implications for cosmology, particularly regarding the origin, evolution, and ultimate fate of the universe.

$$\lambda = \lambda_c + \lambda_d$$

\[\Lambda = \Lambda_c + \Lambda_d \]

- \(\Lambda \) is the cosmological constant.

1. \(\Lambda_c \): the energy density of visible light. This part could represent the energy associated with visible light in the universe.

2. \(\Lambda_d \): the energy density of dark light. This component could be an analogy to dark energy or a form of unknown energy contributing to the accelerated expansion of the universe. Dark light, in this model, appears to be a form of energy or light that does not interact conventionally with observable matter.

Description of Dark Light:

1. Homogeneous and Repulsive Nature:

- Dark light, similar to dark energy, would be a constant and homogeneous form of energy that permeates the entire universe.

- It would exert a repulsive force on matter, contributing to the acceleration of the universe's expansion.

2. Invisibility and Direct Undetectability:

- Dark light, like dark energy, would not be directly observable by current detection methods. Its presence would be inferred from its gravitational effects on the universe.

3. Influence on the Curvature of Space-Time:

- It would influence the curvature of space-time, a property generally attributed to dark energy within the framework of general relativity.

4. Role in Cosmological Models:

- Dark light could be integrated into cosmological models to explain the acceleration of the universe's expansion, similar to dark energy.

5. Link to the Fifth Dimension:

- In this hypothesis, dark light could also be linked to the fifth dimension, which is an extension of the standard theory of cosmology.

6. Implications for Theoretical Physics:

- Introducing dark light as the equivalent of dark energy, but with additional properties related to the fifth dimension, would open new avenues in theoretical physics, requiring a reevaluation of existing models of the universe.

Mathematical Modeling

Wave Function of Dark Light: To represent dark light, let's introduce a complex wave function $\Psi_{\text{ds}}(x,t)$ that depends on space and time. This wave function can be used to describe the quantum state of dark light in the universe.

$$\Psi_{\text{ds}}(x,t) = \int \frac{d^3p}{(2\pi)^3} \frac{1}{\sqrt{2Ep}} \left(a_p e^{-i(px - E_p t)} + a_p^\dagger e^{i(px - E_p t)} \right)$$

$$\Psi_{\text{ds}}(x,t)=\int\frac{d^3p}{(2\pi)^3}\frac{1}{\sqrt{2E_p}}\left(a_p e^{-i(px-E_p t)}+a_p^\dagger e^{i(px-E_pt)}\right)$$

Here, p is the momentum vector, E_p is the energy associated with momentum p, and $a_p, a_p^\dagger$ are the annihilation and creation operators for the states of dark light.

Field Equation for Dark Light: To describe the dynamics of dark light, we can use a field equation similar to the Klein-Gordon equation for a free scalar field, but

extended to include non-linear interactions that could represent the self-interaction of dark light or its interactions with dark matter and dark energy.

$$\left(\Box + m_{\text{ds}}^2\right)\Psi_{\text{ds}} = \lambda|\Psi_{\text{ds}}|^2\Psi_{\text{ds}} - \rho_{\text{ds}}$$

\[
\left(\Box+m_{\text{ds}}^2\right)\Psi_{\text{ds}}=\lambda|\Psi_{\text{ds}}|^2\Psi_{\text{ds}}-\rho_{\text{ds}} \]

Where \(\Box \) is the D'Alembertian operator, \(m_{\text{ds}} \) is the effective mass of the dark light particle, \(\lambda \) is a coupling parameter representing the non-linear interaction, and \(\rho_{\text{ds}} \) is a source term that could be related to the distribution of dark energy in the universe.

Interaction with Matter and Energy: To model the interaction of dark light with conventional matter and energy, we can introduce interaction terms in the total system's Lagrangian that couple \(\Psi_{\text{ds}} \) with matter fields \(\phi \) and electromagnetic fields \(F_{\mu\nu} \).

$$l_{\text{int}} = g_{\text{ds}}\Psi_{\text{ds}}\bar{\phi}\phi + h_{\text{ds}}\Psi_{\text{ds}}F_{\mu\nu}F^{\mu\nu}$$

\[
\mathcal{L}_{\text{int}}=g_{\text{ds}}\Psi_{\text{ds}}\bar{\phi}\phi+h_{\text{ds}}\Psi_{\text{ds}}F_{\mu\nu}F^{\mu\nu} \]

Where \(g_{\text{ds}} \) and \(h_{\text{ds}} \) are coupling constants that represent the intensity of the interaction of dark light with matter and electromagnetic fields, respectively.

Equations Governing Dark and Visible Light:

It would be essential to formulate equations that model the propagation of these two types of light and their mutual interactions. This might require a generalization of Maxwell's equations for electromagnetism, which would account for the unique effects of the fifth dimension on dark light and its relationship with visible light.

Let's assume that visible light and dark light are described by generalized electromagnetic fields that can interact with each other through a fifth dimension. These fields are represented by \(\Psi_{\text{vis}} \) for visible light and \(\Psi_{\text{som}} \) for dark light.

To incorporate the fifth dimension and allow interaction between visible and dark light, we propose the following equation:

$$\Box \Psi_{\text{vis}} + \mu \Psi_{\text{som}} = J_{\text{vis}}$$

\[\Box \Psi_{\text{vis}} + \mu \Psi_{\text{som}} = J_{\text{vis}} \]

$$\Box \Psi_{\text{som}} + \mu \Psi_{\text{vis}} = J_{\text{som}}$$

\[\Box \Psi_{\text{som}} + \mu \Psi_{\text{vis}} = J_{\text{som}} \]

- \(\Box \) is the D'Alembertian operator generalized to the fifth dimension, representing the propagation of fields in extended spacetime.

- \(\Psi_{\text{vis}} \) is the electromagnetic field representing visible light.

- \(\Psi_{\text{som}} \) is the electromagnetic field representing dark light.

- \(\mu \) is a coupling constant quantifying the intensity of the interaction between visible and dark light.

- \(J_{\text{vis}} \) and \(J_{\text{som}} \) are the sources of the fields of visible and dark light, respectively.

This formulation suggests that visible and dark light are not isolated entities but are coupled via a coupling constant \(\mu \), allowing energy or information exchange through the fifth dimension. The source terms \(J_{\text{vis}} \) and \(J_{\text{som}} \) could represent physical processes or interactions generating or modifying these light fields.

To model an interaction between the positive light field (visible light) and the negative light field (dark light) resulting in the acceleration of our universe's expansion, we can consider an approach based on the formalism of field theory. We will introduce scalar fields to represent visible light (\(\phi_{+} \)) and dark light (\(\phi_{-} \)), proposing an interaction that modifies the dynamics of spacetime.

Scalar Field Model

Let \(\phi_{+} \) be the field representing visible light and \(\phi_{-} \) the field representing dark light. The interaction between these fields and the spacetime metric could be modeled by an effective potential energy contributing to the universe's total energy density, thus influencing its expansion rate.

The action \(S \) for our model, integrating the effect of this interaction on the universe's dynamics, could be written as:

$$S = \int d^4x \sqrt{-g} \left(\frac{R}{16\pi G} + \mathcal{L}_{\phi_+} + \mathcal{L}_{\phi_-} + \mathcal{L}_{\text{int}} \right)$$

\[S = \int d^4x \sqrt{-g} \left(\frac{R}{16\pi G} + \mathcal{L}_{\phi_{+}} + \mathcal{L}_{\phi_{-}} + \mathcal{L}_{\text{int}} \right) \]

- \(R \) is the Ricci scalar, reflecting spacetime curvature.

- \(G \) is Newton's gravitational constant.

- \(\mathcal{L}_{\phi_{+}} \) and \(\mathcal{L}_{\phi_{-}} \) are the Lagrangians for visible and dark light fields, respectively, which could take the general form \(\mathcal{L}_{\phi} = -\frac{1}{2} \partial^{\mu} \phi \partial_{\mu} \phi - V(\phi) \).

- \(\mathcal{L}_{\text{int}} \) is the interaction Lagrangian between visible and dark light fields, modeled by a function of these fields, for example, \(\mathcal{L}_{\text{int}} = \lambda (\phi_{+} \phi_{-})^2 \), where \(\lambda \) is a coupling parameter.

To mathematically represent the interaction between dark light (\(\phi_{-} \)) and visible light (\(\phi_{+} \)), as well as their influence on the universe's expansion, we can formulate the following equations using the formalism of quantum field theory. These equations seek to capture the dynamics of these fields and their role in cosmic acceleration:

Field Equations for \(\phi_{+} \) and \(\phi_{-} \):

For visible light (\(\phi_{+} \)):

$$(\Box - m_+^2)\phi_+ + \lambda_+\phi_+^3 = -\gamma(\phi_+\phi_-)$$

\[(\Box - m_{+}^2) \phi_{+} + \lambda_{+} \phi_{+}^3 = -\gamma (\phi_{+} \phi_{-}) \]

For dark light (\(\phi_{-}\)):

$$(\Box - m_-^2)\phi_- + \lambda_-\phi_-^3 = -\gamma(\phi_+\phi_-)$$

\[(\Box - m_{-}^2) \phi_{-} + \lambda_{-} \phi_{-}^3 = -\gamma (\phi_{+} \phi_{-}) \]

- \(\Box \) is the D'Alembertian operator, representing the propagation of fields in spacetime.

- \(m_{+}^2 \) and \(m_{-}^2 \) are the squared masses of the visible and dark light fields, respectively.

- \(\lambda_{+} \) and \(\lambda_{-} \) are the self-interaction constants for each field.

- \(\gamma \) is a coupling constant quantifying the intensity of the interaction between visible and dark light.

Effect on the Universe's Expansion

The effect of this interaction on the acceleration of the universe's expansion can be derived from the modified Einstein equations, where the interaction term contributes to the effective energy density of the universe:

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = 8\pi G(T_{\mu\nu}^{\phi_+} + T_{\mu\nu}^{\phi_-} + T_{\mu\nu}^{\text{int}})$$

\[G_{\mu\nu} + \Lambda g_{\mu\nu} = 8\pi G (T_{\mu\nu}^{\phi_{+}} + T_{\mu\nu}^{\phi_{-}} + T_{\mu\nu}^{\text{int}}) \]

- \(G_{\mu\nu} \) is the Einstein tensor, describing the curvature of spacetime related to the presence of matter and energy.

- \(\Lambda \) is the cosmological constant, which could be affected by the interaction between \(\phi_{+} \) and \(\phi_{-} \).

- \(T_{\mu\nu}^{\phi_{+}} \), \(T_{\mu\nu}^{\phi_{-}} \), and \(T_{\mu\nu}^{\text{int}} \) are the energy-momentum tensors for the fields of visible light, dark light, and their interaction, respectively.

This modeling suggests that the interaction between visible light and dark light contributes to a form of repulsive energy, analogous to dark energy, which accelerates the universe's expansion. The key to this hypothesis lies in the details of \(\mathcal{L}_{\text{int}} \) and how it affects \(\Lambda \), leading to an observed acceleration of expansion.

Dark Light Interaction with Matter and Gravity:

To create a mathematical model supporting the idea of "dark light" interacting with matter, energy, and gravity in the context of a fifth dimension, we can consider a theoretical approach inspired by field theory and general relativity, incorporating elements reflecting the unique nature of dark light and the fifth dimension.

Extension of Spacetime Metric: To include the fifth dimension (\(x^5 \)) and its influence on four-dimensional spacetime, we start with an extended metric:

$$ds^2 = g_{\mu\nu}dx^\mu dx^\nu + \exp(\phi(x^\mu))(dx^5)^2$$

\[ds^2 = g_{\mu\nu}dx^\mu dx^\nu + \exp(\phi(x^\mu)) (dx^5)^2 \]

Here, \(g_{\mu\nu} \) is the four-dimensional spacetime metric tensor, \(dx^\mu \) and \(dx^\nu \) are the differentials of the coordinates, \(\phi(x^\mu) \) is a scalar field modifying the contribution of the fifth dimension, and \(dx^5 \) represents the differential of the fifth dimension.

Dark Light Interaction with Matter and Gravity: Dark light can be modeled as a scalar field \(\Psi \) that interacts with matter and the gravitational field. The action integrating this interaction could be written as:

$$S = \int d^4x \sqrt{-g} \left(\frac{1}{2} \nabla^\mu \Psi \nabla_\mu \Psi - V(\Psi) + \mathcal{L}_{\text{mat}} + \mathcal{L}_{\text{grav}}(\Psi, g_{\mu\nu}) \right)$$

\[S = \int d^4x \sqrt{-g} \left(\frac{1}{2} \nabla^\mu \Psi \nabla_\mu \Psi - V(\Psi) + \mathcal{L}_{\text{mat}} + \mathcal{L}_{\text{grav}}(\Psi, g_{\mu\nu}) \right) \]

where \(\nabla^\mu \) is the covariant derivative operator, \(V(\Psi) \) is a potential describing the self-interaction of dark light, \(\mathcal{L}_{\text{mat}} \) is the matter Lagrangian, and \(\mathcal{L}_{\text{grav}} \) is the Lagrangian describing the interaction of dark light with gravity, potentially modifying the relationship between matter/energy and spacetime curvature.

Coupling with Matter: The interaction of dark light with matter could be represented by a coupling term in the Lagrangian:

$$\mathcal{L}_{\text{int}} = -\frac{1}{2}\xi\Psi^2 T$$

\[\mathcal{L}_{\text{int}} = -\frac{1}{2} \xi \Psi^2 T \]

where \(\xi \) is a coupling constant and \(T \) is the trace of the matter energy-momentum tensor, integrating the effect of dark light on the properties of matter.

Implications for Gravity: The modifications introduced by dark light and the fifth dimension to gravity could be explored through the modified Einstein equations:

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = 8\pi G(T_{\mu\nu} + T_{\mu\nu}^{\Psi})$$

\[G_{\mu\nu} + \Lambda g_{\mu\nu} = 8\pi G (T_{\mu\nu} + T_{\mu\nu}^{\Psi}) \]

where \(G_{\mu\nu} \) is the Einstein tensor, \(\Lambda \) is the cosmological constant, \(T_{\mu\nu} \) is the energy-momentum tensor of matter, and \(T_{\mu\nu}^{\Psi} \) represents the energy-momentum tensor associated with dark light, which includes the effects of the fifth dimension on the distribution and behavior of matter and energy.

This theoretical model proposes a framework to understand how dark light interacts with matter, energy, and gravity in a universe featuring a fifth dimension.

To mathematically represent the analogy between dark light and dark energy as being one and the same entity within the framework of the hypothesis, it would be relevant to reformulate the Einstein equation to directly integrate this idea. If dark light and dark energy are considered different manifestations of the same fundamental phenomenon, one could consider a unification of their contributions to the energy-momentum tensor in the Einstein equation. Here is an attempt at formulation:

$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} + \Lambda g_{\mu\nu} = 8\pi G(T_{\mu\nu}^{\text{matière}} + T_{\mu\nu}^{\text{dark}})$$

\[R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} + \Lambda g_{\mu\nu} = 8\pi G (T_{\mu\nu}^{\text{matter}} + T_{\mu\nu}^{\text{dark}}) \]

- \(R_{\mu\nu} \) is the Ricci tensor, representing the curvature of spacetime due to gravity.

- \(R \) is the scalar curvature, a measure of the total curvature of spacetime.

- \(g_{\mu\nu} \) is the metric tensor, describing the geometry of spacetime.

- Λ is the cosmological constant, traditionally associated with dark energy.

- $T_{\mu\nu}^{\text{matter}}$ is the energy-momentum tensor of ordinary matter, including dark matter.

- $T_{\mu\nu}^{\text{dark}}$ represents a unified energy-momentum tensor for dark light and dark energy, suggesting that these two entities are different manifestations of a single underlying phenomenon in this conceptual universe.

This reformulation highlights the unified approach to treating dark light and dark energy as a single entity in the equations governing gravity and cosmic dynamics. It suggests a new perspective on how dark energy (including dark light) influences the acceleration of the universe's expansion, while remaining consistent with the principles of general relativity.

Description of the 5th Dimension

In this context, the fifth dimension could be described as an additional dimension that coexists with the 4 known dimensions. However, in this 5th dimension, light would not move in a classical manner, but would instead exist as a constant, like a vibrating spider web in which matter particles interact (omnipresent field). As for time, it would no longer flow through this 5th dimension but would be replaced by a notion of Eternal Present, where all events exist simultaneously. The entirety of positive (+) and negative (-) light would belong to the 5th dimension. To summarize:

Non-Visible and Immaterial: This fifth dimension would not be something visible or tangible in our three-dimensional reality. It cannot be directly perceived by our senses or by conventional measuring instruments.

Static and Omnipresent: Unlike the four classical dimensions (three spatial and one temporal), this fifth dimension would be static. It does not imply movement or change over time. It is described as a sort of "vibrating spider web" that permeates all space but remains unchangeable.

Interaction with Matter: In this dimension, matter would interact with "light" that is already present everywhere simultaneously. This interaction would not depend on the transmission of light through space, but rather on the presence of matter in this omnipresent field.

Positive and Negative Light: The fifth dimension would include aspects of both positive and negative light (or dark light), potentially representing forms of energy or states of light that are beyond our current understanding.

Eternal Present: Time, as we understand it, would not flow in this dimension. Rather than being linear, time would be an "eternal present," where all events exist simultaneously.

Relation with the Anti-Universe: This dimension could act as a bridge or link between our universe and a hypothetical anti-universe, allowing interactions or transitions between these two realities.

Influence on Physical Properties: The fifth dimension could influence or modify the physical properties of matter and energy in our universe, although the exact nature of these influences is speculative.

$$[D_5 = \text{Const} \times \Omega \times l_{\text{int}} \times \tau^{infty} \times \mathbb{I}]$$

\[D_5 = \text{Const} \times (\text{Vibrating Spider Web}) \times (\text{Interaction of Matter Particles}) \times \tau^\infty \times \mathbb{L} \]

In this hypothesis, the Present and the lights are linked to the 5th dimension in a perpetual moment where all past and future events exist simultaneously. This suggests that the perception of time is relative to our consciousness rather than being in fundamental reality. Events do not unfold in spacetime because this space no longer exists, but rather from a simultaneous sampling of all events. To mathematically conceptualize the description of a fifth dimension uniformly superimposed over our usual four dimensions and an anti-universe (see below), and its possible implications on physics, we can consider a formulation that integrates this additional dimension into a unified theory. Here is a simplified equation that attempts to capture these ideas within the framework of an extension of the spacetime metric:

$$ds^2 = (g_{\mu\nu} + \kappa h_{\mu\nu})dx^\mu dx^\nu + \exp(2\phi)(dx^5)^2$$

\[ds^2 = (g_{\mu\nu} + \kappa h_{\mu\nu})dx^\mu dx^\nu + \exp(2\phi) (dx^5)^2 \]

- \(ds^2\) is the spacetime interval.

- \(g_{\mu\nu}\) is the four-dimensional spacetime metric tensor, describing the geometry of our observable universe.

- $h_{\mu\nu}$ represents modifications or perturbations of the metric due to the presence of the fifth dimension, considered here as small and treated as a perturbation of the background metric tensor $g_{\mu\nu}$.

- κ is a coupling factor that determines the intensity of the fifth dimension's influence on four-dimensional spacetime.

- ϕ is a scalar field that depends on the coordinates of the four-dimensional spacetime and modifies the metric of the fifth dimension, $\exp(2\phi)$ reflects how the geometry of this additional dimension is uniformly integrated across spacetime.

- dx^μ and dx^ν are the differentials of the four-dimensional spacetime coordinates.

- dx^5 is the differential of the coordinate associated with the fifth dimension.

This equation attempts to encapsulate the idea that the fifth dimension is intrinsically linked and uniformly distributed relative to our usual spacetime, potentially affecting the geometry of the universe in subtle but fundamental ways. The scalar field ϕ allows for continuous modulation of the fifth dimension's effect, which could correspond to variations in observable physical properties or fundamental constants depending on the position in spacetime.

Implications and Exploration

1. **Unification of Forces:** This formulation could be explored in the context of theories aiming to unify the fundamental interactions, including gravity, with other forces, within a multidimensional framework.

2. **Cosmology and Dark Energy:** By modifying spacetime geometry, the fifth dimension could play a role in explaining the acceleration of the universe's expansion, often attributed to dark energy.

3. **Quantum Phenomena:** The uniform influence of the fifth dimension could also have implications for understanding quantum phenomena, such as entanglement and non-locality.

This equation reflects how the fifth dimension might be integrated into the structure of spacetime in our universe, modifying the known geometry and introducing new effects via the scalar field ϕ and metric perturbations $h_{\mu\nu}$. It suggests a venue for exploring how additional dimensions might influence known physics, potentially offering a new framework for understanding phenomena such as gravity, dark energy, and fundamental interactions.

Geometry of the Fifth Dimension:

Compactified Geometry

The fifth dimension could be compactified, akin to models inspired by Kaluza-Klein theory or Calabi-Yau manifolds in string theory. Such geometry would allow the dimension to be "wrapped" at a microscopic scale, making it imperceptible to our current measuring instruments while allowing subtle interactions through it. This approach is compatible with the idea that the effects of this additional dimension, such as the interaction between dark light and visible light or the dynamics between the universe and anti-universe, could manifest primarily through modified gravitational forces or non-standard interactions.

Universe and Anti-Universe:

What if the universe breathes! Imagine the universe expanding into an anti-universe until the moment when the reverse happens, that is, our universe begins to contract, and its anti-universe expands in turn. We find this form of alternating duality almost in all areas of life. The cycle of day and night, inhalation and exhalation, photosynthesis, white and black...

Here is a possible description of this scenario:

1. **Expansion Phase:** In the current phase, our universe is expanding, extending into the space of the anti-universe. Meanwhile, the anti-universe might be in a phase of contraction or stability.

2. **Transition Point:** At a certain moment, an unknown triggering event or mechanism initiates the change. Our universe begins to contract, while the anti-universe starts its expansion.

3. **Contraction Phase:** Our universe contracts, possibly following a process similar but inverse to the Big Bang expansion, often called the "Big Crunch." Meanwhile, the anti-universe expands.

4. **Cosmic Cycle:** This process could be cyclic. After the contraction of our universe and the complete expansion of the anti-universe, a new event similar to the Big Bang could occur, reversing the dynamics again.

5. **Conservation and Symmetry:** This model would suggest a kind of conservation or global symmetry at a cosmic scale. Energy, space, or other fundamental properties could be exchanged or transformed between the two universes during these cycles.

6. **Implications for Physics:** Such a model would challenge many aspects of current cosmological physics, especially regarding the nature of dark energy, gravity, and the large-scale structure of the universe.

7. **Mysteries and Unknowns:** This scenario raises questions about the nature of the transition between expansion and contraction, the underlying mechanisms governing these phases, and how these processes might be observed or measured.

Assuming the evolution of the size of the universe (and the anti-universe) is a function of time \(t\). One could define a function \(f(t)\) for our universe and \(g(t)\) for the anti-universe. These functions could be designed to reflect expansion and contraction:

$$f(t) = A \cdot \sin(\omega t + \phi)$$

\[f(t) = A \cdot \sin(\omega t + \phi) \]

$$g(t) = A \cdot \cos(\omega t + \phi)$$

\[g(t) = A \cdot \cos(\omega t + \phi) \]

In these equations:

- \(f(t)\) represents the state of the universe (expanding or contracting) as a function of time \(t\).

- \(g(t)\) represents the state of the anti-universe.

- \(A\) is the maximum amplitude of expansion or contraction.

- \(\omega \) is the frequency of the expansion and contraction cycles.

- \(\phi \) is the initial phase that determines the start of the cycle.

The use of sine and cosine functions here suggests that when the universe is at maximum expansion (the value of \(f(t)\) is at its peak), the anti-universe is in a neutral phase (where \(g(t)\) is at the lowest or highest point of its curve), and vice versa.

These equations are a simplified and hypothetical representation of this concept of the universe and the anti-universe in alternating expansion and contraction.

Einstein Equations for the Universe and Anti-Universe:

For our universe:

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

\[G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu} \]

For the anti-universe:

$$\tilde{G}_{\mu\nu} + \tilde{\Lambda}\tilde{g}_{\mu\nu} = -\frac{8\pi G}{c^4} \tilde{T}_{\mu\nu}$$

\[\tilde G_{\mu\nu} + \tilde\Lambda \tilde g_{\mu\nu} = \frac{8\pi G}{c^4} \tilde T_{\mu\nu} \]

Here, \(\tilde G_{\mu\nu} \), \(\tilde\Lambda \), \(\tilde g_{\mu\nu} \), and \(\tilde T_{\mu\nu} \) represent the equivalents in the anti-universe of the terms for the Einstein tensor, cosmological constant, metric tensor, and energy-momentum tensor, respectively. The negative sign in the anti-universe's equation could symbolize an inversion of physical properties.

Integrating our 5th dimension into our universe and our anti-universe in such a way to link them through the 5th dimension described in this hypothesis. In this context, the fifth dimension would act as a bridge or link between the two universes, allowing some form of communication or transition between them. Here is an approach to conceptualize this:

Assuming \(x^0\), \(x^1\), \(x^2\), and \(x^3\) represent the four usual dimensions of spacetime. The fifth dimension could be represented by an additional coordinate \(x^4\). The equations describing the universe and the anti-universe could then be extended to include this fifth dimension

.For our universe:

$$G_{\mu\nu}(x^0, x^1, x^2, x^3, x^4) + \Lambda g_{\mu\nu}(x^0, x^1, x^2, x^3, x^4) = \frac{8\pi G}{c^4} T_{\mu\nu}(x^0, x^1, x^2, x^3, x^4)$$

\[G_{\mu\nu}(x^0, x^1, x^2, x^3, x^4) + \Lambda g_{\mu\nu}(x^0, x^1, x^2, x^3, x^4) = \frac{8\pi G}{c^4} T_{\mu\nu}(x^0, x^1, x^2, x^3, x^4) \]

For the anti-universe:

$$\tilde{G}_{\mu\nu}(x^0, x^1, x^2, x^3, x^4) + \tilde{\Lambda}\tilde{g}_{\mu\nu}(x^0, x^1, x^2, x^3, x^4) = -\frac{8\pi G}{c^4}\tilde{T}_{\mu\nu}(x^0, x^1, x^2, x^3, x^4)$$

\[\tilde{G}_{\mu\nu}(x^0, x^1, x^2, x^3, x^4) + \tilde{\Lambda} \tilde{g}_{\mu\nu}(x^0, x^1, x^2, x^3, x^4) = -\frac{8\pi G}{c^4} \tilde{T}_{\mu\nu}(x^0, x^1, x^2, x^3, x^4) \]

Interconnection via the 5th Dimension:

The interconnection between universes could be represented by a kind of function or relationship that links physical properties in both universes through the fifth dimension. For example:

$$F(x^0, x^1, x^2, x^3, x^4) = \text{lien entre univers et anti-univers}$$

\[F(x^0, x^1, x^2, x^3, x^4) = \text{link between universe and anti-universe} \]

This hypothetical function \(F \) could describe how events or properties in one universe affect or are reflected in the other.

According to the hypothesis in question, positive light (+) from our universe would become dark light (-) in the anti-universe and conversely, positive light from the anti-universe would become dark light in our universe.

To mathematically formalize this idea, taking into account the fifth dimension as a link between the two, we could introduce equations that reflect this transformation:

Transformation of Light between Universes:

For our universe, let \(\psi_{+}(x^0, x^1, x^2, x^3, x^4) \) be the wave function representing positive light. In the anti-universe, this light becomes dark or negative, represented by \(\psi_{-}(x^0, x^1, x^2, x^3, x^4) \):

Transformation of positive light from the anti-universe into dark light in our universe:

$$\psi_{+}^{(\text{anti-univers})}(x^0, x^1, x^2, x^3, x^4) \rightarrow \psi_{-}^{(\text{univers})}(x^0, x^1, x^2, x^3, x^4)$$

\[\psi_{+}^{\text{(anti-universe)}}(x^0, x^1, x^2, x^3, x^4) \rightarrow \psi_{-}^{\text{(universe)}}(x^0, x^1, x^2, x^3, x^4) \]

Transformation of positive light from our universe into dark light in the anti-universe:

$$\psi_{+}^{(\text{univers})}(x^0, x^1, x^2, x^3, x^4) \rightarrow \psi_{-}^{(\text{anti-univers})}(x^0, x^1, x^2, x^3, x^4)$$

\[\psi_{+}^{\text{(universe)}}(x^0, x^1, x^2, x^3, x^4) \rightarrow \psi_{-}^{\text{(anti-universe)}}(x^0, x^1, x^2, x^3, x^4) \]

To integrate the notion of a fifth dimension and the transformation of light between the universe and the anti-universe within the frameworks of classical and quantum

physics, we need to extend Maxwell's equations and the Dirac equation to include this additional dimension.

Extension of Maxwell's Equations:

Maxwell's equations describe the behavior of electric and magnetic fields. To integrate a fifth dimension (\(x^4\)), one could consider an extension where partial derivatives are taken with respect to this additional dimension, in addition to the four dimensions of spacetime.

$$\nabla_5 \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0} + \frac{\partial E_4}{\partial x^4}, \quad \nabla_5 \cdot \mathbf{B} = 0 + \frac{\partial B_4}{\partial x^4}$$

\[\nabla_5 \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0} + \frac{\partial E_4}{\partial x^4}, \quad \nabla_5 \cdot \mathbf{B} = 0 + \frac{\partial B_4}{\partial x^4} \]

$$\nabla_5 \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} - \nabla_5 B_4, \quad \nabla_5 \times \mathbf{B} = \mu_0\mathbf{J} + \mu_0\varepsilon_0\frac{\partial \mathbf{E}}{\partial t} + \nabla_5 E_4$$

\[\nabla_5 \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} - \nabla_5 B_4, \quad \nabla_5 \times \mathbf{B} = \mu_0\mathbf{J} + \mu_0\varepsilon_0\frac{\partial \mathbf{E}}{\partial t} + \nabla_5 E_4 \]

In a 5-dimensional space (\(x^0,x^1,x^2,x^3,x^4\))

where \(\nabla_5\) represents the derivation operator including the fifth dimension, and \(E_4\) and \(B_4\) are the components of the electric and magnetic field in this fifth dimension.

Extension of the Dirac Equation:

The Dirac equation describes the behavior of elementary particles, like electrons, with spin 1/2, accounting for relativistic effects. To extend it to a fifth dimension, one could introduce an additional term associated with \(x^4\), which would require a generalization of the Dirac gamma matrices (\(\gamma^\mu\)) to include the fifth dimension:

$$(i\gamma^\mu \partial_\mu + i\gamma^4 \partial_4 - m)\psi(x^0, x^1, x^2, x^3, x^4) = 0$$

\[(i\gamma^\mu \partial_\mu + i\gamma^4 \partial_4 - m)\psi(x^0, x^1, x^2, x^3, x^4) = 0 \]

where \(\gamma^4\) would be a new gamma matrix associated with the fifth dimension, and \(\partial_4\) the partial derivative with respect to \(x^4\). This extension assumes the existence of an algebraic representation that satisfies the Clifford algebra in 5 dimensions, which is non-trivial and requires a generalization of spin properties and fundamental interactions.

Transformation and Transfer via the Fifth Dimension:

1. **Conversion Mechanism:** The fifth dimension acts as a medium or conduit through which visible light from the anti-universe is converted into dark light when entering our universe. This conversion could involve physical processes or laws yet unknown that allow such energy transformation.

2. **Energy Balance:** This hypothesis suggests a certain balance or symmetry between the two universes, where energy is not lost but simply transformed and redistributed through the fifth dimension. This would imply that the expansion of our universe and the increasing presence of dark energy could be directly linked to processes occurring in the anti-universe.

3. **Role of the Fifth Dimension:** The fifth dimension is crucial in this model, not only in facilitating the transformation of visible light into dark light but also in serving as a link between our universe and the anti-universe. This suggests that the fifth dimension possesses unique properties that allow such energetic interactions.

Expansion Phase: Initially, our universe expands due to the continuous transformation of visible light from the anti-universe into dark light (dark energy) in our universe. This dark energy acts as a repulsive force that accelerates the universe's expansion.

Depletion of Visible Light: The expansion continues until the reserve of visible light in the anti-universe, which can be transformed into dark energy, is exhausted. At this point, the mechanism powering our universe's expansion ceases to function.

Reversal of the Process: With the depletion of the dark energy source from the anti-universe, our universe begins to contract. Simultaneously, the anti-universe, having lost some of its visible light, begins an expansion process, perhaps by transforming a form of energy equivalent to the dark light in our universe into a new form of visible light in the anti-universe.

Cosmic Cycle: This process suggests a cosmic cycle where the universes alternate between expansion and contraction phases. The exact dynamics of this cycle would depend on the properties of the fifth dimension and the laws governing the transformation of energy between the two universes.

Transformation of Light from the Anti-Universe to Our Universe:

$$\frac{\partial \psi_{-}^{(\text{univers})}(x^{\mu}, x^{4})}{\partial x^{4}} = \alpha \psi_{+}^{(\text{anti-univers})}(x^{\mu}, x^{4}) - \beta \psi_{-}^{(\text{univers})}(x^{\mu}, x^{4})$$

\[\frac{\partial \psi_{-}^{\text{(universe)}}(x^\mu, x^4)}{\partial x^4} = \alpha \psi_{+}^{\text{(anti-universe)}}(x^\mu, x^4) - \beta \psi_{-}^{\text{(universe)}}(x^\mu, x^4) \]

This equation models how positive light (\(\psi_{+}^{\text{(anti-universe)}}\)) from the anti-universe is transformed into dark light (\(\psi_{-}^{\text{(universe)}}\)) in our universe via the fifth dimension, with \(\alpha\) and \(\beta\) as transformation constants.

Transformation of Light from Our Universe to the Anti-Universe:

Here, \(\alpha'\) and \(\beta'\) are the transformation constants for the reverse process, where visible light (\(\psi_{+}^{\text{(universe)}}\)) from our universe is converted into dark light (\(\psi_{-}^{\text{(anti-universe)}}\)) in the anti-universe.

$$\frac{\partial \psi_{-}^{(\text{anti-univers})}(x^{\mu}, x^{4})}{\partial x^{4}} = \alpha' \psi_{+}^{(\text{univers})}(x^{\mu}, x^{4}) - \beta' \psi_{-}^{(\text{anti-univers})}(x^{\mu}, x^{4})$$

\[\frac{\partial \psi_{-}^{\text{(anti-universe)}}(x^\mu, x^4)}{\partial x^4} = \alpha' \psi_{+}^{\text{(universe)}}(x^\mu, x^4) - \beta' \psi_{-}^{\text{(anti-universe)}}(x^\mu, x^4) \]

Global Equation of Energy Conservation:

$$E_{\text{total}} = \gamma \left(\int |\psi_{+}^{(\text{univers})}(x^\mu, x^4)|^2 \, d^4x \, dx^4 + \int |\psi_{+}^{(\text{anti-univers})}(x^\mu, x^4)|^2 \, d^4x \, dx^4 \right)$$

\[E_{\text{total}} = \gamma \left(\int |\psi_{+}^{\text{(universe)}}(x^\mu, x^4)|^2 \, d^4x \, dx^4 + \int |\psi_{+}^{\text{(anti-universe)}}(x^\mu, x^4)|^2 \, d^4x \, dx^4 \right) \]

where \(E_{\text{total}}\) represents the total energy involved in these inter-dimensional transformations, and \(\gamma\) is a proportional constant that links the total energy to the sum of the probability densities of positive light in both universes.

Interconnection Equations via the 5th Dimension:

The modified Einstein equations for both universes could incorporate these light transformations:

For Our Universe:

$$G_{\mu\nu}^{(5)} + \Lambda^{(5)} g_{\mu\nu}^{(5)} = \frac{8\pi G}{c^4} \left(T_{\mu\nu}^{(5)} + \psi_{+}^{(5)} - \psi_{-}^{(5)} \right)$$

\[G_{\mu\nu}^{(5)} + \Lambda^{(5)} g_{\mu\nu}^{(5)} = \frac{8\pi G}{c^4} \left(T_{\mu\nu}^{(5)} + \psi_{+}^{(5)} - \psi_{-}^{(5)} \right) \]

For the Anti-Universe:

$$\tilde{G}_{\mu\nu}^{(5)} + \tilde{\Lambda}^{(5)} \tilde{g}_{\mu\nu}^{(5)} = -\frac{8\pi G}{c^4} \left(\tilde{T}_{\mu\nu}^{(5)} + \psi_{-}^{(5)} - \psi_{+}^{(5)} \right)$$

\[\tilde{G}_{\mu\nu}^{(5)} + \tilde{\Lambda}^{(5)} \tilde{g}_{\mu\nu}^{(5)} = -\frac{8\pi G}{c^4} \left(\tilde{T}_{\mu\nu}^{(5)} + \psi_{-}^{(5)} - \psi_{+}^{(5)} \right) \]

In these equations:

- \(G_{\mu\nu}^{(5)}\) and \(\tilde{G}_{\mu\nu}^{(5)}\) represent the generalized Einstein tensors for the universe and anti-universe, respectively, in a fifth dimension.

- \(\Lambda^{(5)}\) and \(\tilde{\Lambda}^{(5)}\) are the generalized cosmological constants for each universe.

- \(g_{\mu\nu}^{(5)}\) and \(\tilde{g}_{\mu\nu}^{(5)}\) are the five-dimensional metric tensors.

- \(T_{\mu\nu}^{(5)}\) and \(\tilde{T}_{\mu\nu}^{(5)}\) are the generalized energy-momentum tensors.

- \(\psi_{+}^{(5)}\) and \(\psi_{-}^{(5)}\) represent the terms corresponding to positive and dark light in a fifth dimension for the universe, and vice versa for the anti-universe.

The fifth dimension could be expressed by a function that links these light transformations between the two universes:

$$F_5(x^0, x^1, x^2, x^3, x^4) = \text{transformation de } \psi_+ \text{ en } \psi_- \text{ et vice versa}$$

\[F_5(x^0, x^1, x^2, x^3, x^4) = \text{transformation of }\psi_{+}\text{ into }\psi_{-}\text{ and vice versa} \]

To model the transformation of positive light (\(\psi_{+}\)) into dark light (\(\psi_{-}\)) and vice versa via a fifth dimension, we can consider a differential equation that captures this dynamic. Such an equation could be based on the idea that the fifth dimension induces a coupling between these two types of light, modifying their states based on this additional dimension.

Consider the wave functions \(\psi_{+}\) and \(\psi_{-}\) as depending not only on the four dimensions of spacetime (\(x^0, x^1, x^2, x^3\)) but also on the fifth dimension (\(x^4\)). One way to represent the transformation could be:

$$\frac{\partial}{\partial x^4}\psi_+(x^0, x^1, x^2, x^3, x^4) = \alpha\psi_-(x^0, x^1, x^2, x^3, x^4)$$

\[\frac{\partial}{\partial x^4} \psi_{+}(x^0, x^1, x^2, x^3, x^4) = \alpha \psi_{-}(x^0, x^1, x^2, x^3, x^4) \]

$$\frac{\partial}{\partial x^4}\psi_-(x^0, x^1, x^2, x^3, x^4) = \beta\psi_+(x^0, x^1, x^2, x^3, x^4)$$

\[\frac{\partial}{\partial x^4} \psi_{-}(x^0, x^1, x^2, x^3, x^4) = \beta \psi_{+}(x^0, x^1, x^2, x^3, x^4) \]

where α and β are constants characterizing the intensity of the light transformation due to the fifth dimension. These equations suggest that the derivative of the positive light wave function with respect to the fifth dimension is proportional to the dark light wave function, and vice versa.

Interpretation:

- **Coupling between Positive and Dark Light:** These equations model a direct coupling between positive and dark light through the fifth dimension, where a variation of one in this additional dimension leads to the manifestation or intensification of the other.

- **Role of the Fifth Dimension:** The explicit dependence on x^4 underscores the role of the fifth dimension as a transformation mechanism between the two types of light.

- **Transformation Constants:** The constants α and β reflect the specificity of the transformation in this dimension, possibly related to the nature of the fifth dimension or the intrinsic properties of the universes.

Interaction Between Universe and Anti-Universe:

The idea of an anti-universe interacting with our universe through the fifth dimension opens up perspectives on the cyclic nature of the universe and the possibility of energy or matter exchanges between these two universes. To model these interactions, it would be necessary to develop a framework that describes how energy, matter, and potentially other forms of information could be transferred or transformed between the universes. This might involve creating new equations or refining Einstein's equations to include terms that represent these inter-universe interactions.

Imagine the universe and the anti-universe described as branes (sheets) in a larger multidimensional space (the "bulk"). The fifth dimension facilitates interaction between these branes, allowing the exchange of energy, matter, or information through this additional dimension.

A simplified model to describe this interaction could draw from the theory of curved space fields, modifying Einstein's equations to incorporate the effects of the fifth dimension and interactions between the branes.

Extension of the Metric Tensor

The metric tensor can be generalized to include the fifth dimension:

$$g_{AB} = \begin{pmatrix} g_{\mu\nu} & 0 \\ 0 & g_{55} \end{pmatrix}$$

\[g_{AB} = \begin{pmatrix}g_{\mu\nu} & 0 \\0 & g_{55}\end{pmatrix} \]

where \(A,B\) run over all dimensions (0, 1, 2, 3, 5), \(g_{\mu\nu}\) is the four-dimensional spacetime metric tensor, and \(g_{55}\) is a term describing the geometry of the fifth dimension.

Action and Field Equations

The action integrating the contributions of the universe and the anti-universe, as well as their interaction via the fifth dimension, could be written as:

$$S = \int d^5x \sqrt{-g}(R + L_{\text{mat}} + L_{\text{inter}})$$

\[S = \int d^5x \sqrt{-g} (R + L_{\text{mat}} + L_{\text{inter}}) \]

\(R\) is the Ricci scalar, derived from the extended metric tensor \(g_{AB}\), representing the curvature of five-dimensional spacetime. \(L_{\text{mat}}\) is the matter Lagrangian, which includes terms for matter in both universes. \(L_{\text{inter}}\) is the interaction Lagrangian, modeling the exchange of energy or information through the fifth dimension.

Boundary Conditions and Interaction

The boundary conditions for the fields at the separation surface between the universe and the anti-universe can be described by:

$$[\phi] = 0, \quad [\partial_5 \phi] = J(\phi_{\text{univ}}, \phi_{\text{anti-univ}})$$

\[[\phi] = 0, \quad [\partial_5 \phi] = J(\phi_{\text{univ}}, \phi_{\text{anti-univ}}) \]

where \([\phi]\) represents the discontinuity of the field \(\phi\) across the fifth dimension, and \(J\) is an interaction source that depends on the field states in the universe and the anti-universe.

This model is a simplification to illustrate how interactions between the universe and the anti-universe could be conceptualized and mathematically formalized. The reality of such a system would be infinitely more complex and would require much more extensive theoretical elaboration, possibly incorporating ideas from string theory, brane cosmology, or other approaches in quantum gravity that allow for additional dimensions and multiple universes.

The key point here is to demonstrate that an approach based on established physical principles and extended to additional dimensions can provide a framework for conceptualizing and, potentially, mathematically modeling interactions between our universe and a potential anti-universe through an additional dimension.

The interaction between the universes and the anti-universe can be modeled by modifying Einstein's equations to include the fifth dimension and interaction terms:

$$G_{\mu\nu}^{(5)} + \Lambda^{(5)} g_{\mu\nu}^{(5)} = \frac{8\pi G}{c^4} T_{\mu\nu}^{(5)} + \kappa \left(\Psi_{\mu}^{(5)} \Psi_{\nu}^{(5)} - \frac{1}{2} g_{\mu\nu}^{(5)} \Psi_{\lambda}^{(5)} \Psi^{\lambda(5)} \right)$$

\[G_{\mu\nu}^{(5)} + \Lambda^{(5)} g_{\mu\nu}^{(5)} = \frac{8\pi G}{c^4} T_{\mu\nu}^{(5)} + \kappa \left(\Psi_{\mu}^{(5)} \Psi_{\nu}^{(5)} - \frac{1}{2} g_{\mu\nu}^{(5)} \Psi_{\lambda}^{(5)} \Psi^{\lambda(5)} \right) \]

Additional Terms:

- \(G_{\mu\nu}^{(5)}\): Five-dimensional Einstein tensor

- \(\Lambda^{(5)}\): Five-dimensional cosmological constant

- \(g_{\mu\nu}^{(5)}\): Five-dimensional metric tensor

- \(T_{\mu\nu}^{(5)}\): Total energy-momentum tensor including contributions from both universes and the fifth dimension

- \(\kappa\): Coupling constant between matter and dark light

- \(\Psi_{\mu}^{(5)}\): Five-dimensional dark light field

Conservation Equations:

Energy and matter are conserved in each universe and in the fifth dimension:

$$\nabla_\mu T^{\mu\nu}_{(u)} = 0, \quad \nabla_\mu T^{\mu\nu}_{(a)} = 0, \quad \nabla_\mu T^{\mu\nu}_{(5)} = 0$$

\[\begin{align*}

\nabla_\nu T^{\mu\nu}_{(u)} &= 0, \\

\nabla_\nu T^{\mu\nu}_{(a)} &= 0, \\

\nabla_\nu T^{\mu\nu}_{(5)} &= 0

\end{align*}\]

Dark Light Equations: The evolution of the dark light field is described by a wave equation:

$$\Box(\Psi^{(5)}_\mu) + m^2\Psi^{(5)}_\mu = -2\kappa\rho_{(u)}\Psi^{(5)}_\mu + 2\kappa\rho_{(a)}\Psi^{(5)}_\mu$$

\Box \psi_\mu^{(5)} + m^2 \psi_\mu^{(5)} = -2\kappa(\partial_\nu \psi^{\nu(5)} \psi_\mu^{(5)} + 2\kappa\partial_\mu \psi^{(a)} \psi_\mu^{(5)})

m\): Mass of the dark light

- \(\rho(u)\): Energy density of the universe

- \(\rho(a)\): Energy density of the anti-universe

This formulation offers a rich mathematical framework for exploring the consequences of interaction between universes through a fifth dimension, potentially paving the way for new discoveries in cosmology and theoretical physics.

Universe Expansion into the Anti-Universe:

To mathematically express that the universe expands into the anti-universe through a fifth dimension, one can conceptualize an equation that models the interaction between the universe and the anti-universe via this additional dimension. The goal would be to capture the idea that the universe's expansion is linked to an exchange or dynamic with the anti-universe, facilitated by the fifth dimension. Here is a proposed simplified equation to illustrate this idea:

$$\frac{\partial}{\partial x^5}(\rho_{\text{univ}} - \rho_{\text{anti-univ}}) = \kappa \cdot \Psi_{\text{5D}}$$

\[\frac{\partial}{\partial x^5} (\rho_{\text{univ}} - \rho_{\text{anti-univ}}) = \kappa \cdot \Psi_{\text{5D}} \]

\(\partial x^5\) represents the partial derivative with respect to the fifth dimension coordinate, \(x^5\), illustrating the effect of this dimension on the exchange between the two universes. \(\rho_{\text{univ}}\) and \(\rho_{\text{anti-univ}}\) are the energy (or matter) densities of the universe and the anti-universe, respectively. Their difference reflects an imbalance or dynamic interaction between the two, facilitated by the fifth dimension. \(\kappa\) is a coupling constant that moderates the intensity of the interaction through the fifth dimension. \(\Psi_{\text{5D}}\) is a field or function representing the specific properties or effects of the fifth dimension on this interaction. This field could include aspects of "dark light" or other forms of energy or information that transit between the universe and the anti-universe.

To create a mathematical model based on the hypothesis that integrates the idea that the universe expands into the anti-universe via the fifth dimension, we need to formulate a set of equations that capture the dynamic interactions between the universe, the anti-universe, and the fifth dimension. This model will seek to describe how energy, matter, and "dark light" transform and interact across these realms. Here is an approach to construct this model:

We start by defining fields representing the energy density of the universe (\(\rho_{\text{univ}}\)) and the anti-universe (\(\rho_{\text{anti-univ}}\)), and we introduce "dark light" (\(\Psi_{\text{5D}}\)) as a field in the fifth dimension that facilitates the interaction between the two.

Fundamental Equations:

1. Dark Light Dynamics in the Fifth Dimension:

$$\Box^{(5)}\Psi_{\text{5D}} + m^2\Psi_{\text{5D}} = -\lambda(\rho_{\text{univ}} + \rho_{\text{anti-univ}})\Psi_{\text{5D}}$$

\[\Box^{(5)} \Psi_{\text{5D}} + m^2 \Psi_{\text{5D}} = -\lambda (\rho_{\text{univ}} + \rho_{\text{anti-univ}}) \Psi_{\text{5D}} \]

This equation describes how dark light is affected by the presence of matter and energy in the universe and the anti-universe, where \(\Box^{(5)}\) is the five-dimensional d'Alembert operator, \(m\) is the mass of the dark light field, and \(\lambda\) is a coupling parameter.

2. Interaction between the Universe and the Anti-Universe via the Fifth Dimension:

$$\frac{\partial}{\partial x^5}(\rho_{\text{univ}} - \rho_{\text{anti-univ}}) = \kappa \cdot \Psi_{\text{5D}}$$

\[\frac{\partial}{\partial x^5} (\rho_{\text{univ}} - \rho_{\text{anti-univ}}) = \kappa \cdot \Psi_{\text{5D}} \]

This equation expresses that the rate of change of the energy density difference between the universe and the anti-universe through the fifth dimension is proportional to the "dark light", where \(\kappa\) is a proportionality factor.

3. Conservation of Energy and Matter:

For the model to be consistent, it must respect the conservation of energy and matter throughout the universe-anti-universe system:

$$\partial_\mu T^{\mu\nu}_{\text{univ}} + \partial_\mu T^{\mu\nu}_{\text{anti-univ}} + \partial_5 J^5_{\text{5D}} = 0$$

\[\partial_\mu T^{\mu\nu}_{\text{univ}} + \partial_\mu T^{\mu\nu}_{\text{anti-univ}} + \partial_5 J^5_{\text{5D}} = 0 \]

where \(T^{\mu\nu}_{\text{univ}}\) and \(T^{\mu\nu}_{\text{anti-univ}}\) are the energy-momentum tensors of the universe and the anti-universe respectively, and \(J^5_{\text{5D}}\) represents the energy flux through the fifth dimension.

This mathematical model proposes a framework for studying how the universe and the anti-universe might interact through an additional dimension, focusing on the dynamics of "dark light" as a mediator of these interactions.

Universe Expansion Model into the Anti-Universe via the 5th Dimension:

\(\Psi_{\text{ds}}\) as the dark light field in the fifth dimension and \(g_{\mu\nu}\) as the metric tensor of our universe.

Field Equation for Dark Light and Interaction with the Universe and Anti-Universe:

$$\left(\Box^{(5)} + m_{\text{ds}}^2\right)\Psi_{\text{ds}} = \gamma\left(\rho_{\text{univ}} - \rho_{\text{anti-univ}}\right)$$

\[\left(\Box^{(5)} +m_{\text{ds}}^2 \right) \Psi_{\text{ds}} = \gamma \left(\rho_{\text{univ}} - \rho_{\text{anti-univ}} \right) \]

Dynamics of the Universe and Anti-Universe Expansion:

$$\frac{d}{dt}(V_{\text{univ}} - V_{\text{anti-univ}}) = \eta \int \Psi_{\text{ds}} d^5x$$

\[\frac{d}{dt}\left(V_{\text{univ}} - V_{\text{anti-univ}} \right) = \eta \int \Psi_{\text{ds}} d^5x \]

- \(\Box^{(5)}\) is the five-dimensional d'Alembert operator.

- \(m_{\text{ds}}\) is the effective mass associated with the dark light field.

- γ is a coupling coefficient representing the interaction between dark light and the energy densities of the universe and the anti-universe.

- ρ_{univ} and $\rho_{\text{anti-univ}}$ are the energy densities of the universe and the anti-universe, respectively.

- V_{univ} and $V_{\text{anti-univ}}$ represent the volumes of the universe and the anti-universe.

- η is a coefficient that moderates the effect of dark light on the expansion of the universe and the anti-universe.

These equations aim to formalize the idea that the universe's expansion into the anti-universe is mediated by interactions with dark light in a fifth dimension, highlighting a possible mechanism behind the observed acceleration of cosmic expansion and the dynamics between universes.

Matter and Antimatter:

According to the proposed hypothesis, it is conceivable that antimatter primarily resides in the anti-universe. This idea is based on the notion that our universe and the anti-universe are two distinct but interconnected entities, where the physical laws and matter composition could mirror each other. In this framework, while our universe is predominantly composed of matter, the anti-universe would be composed mainly of antimatter.

This duality between the universe and the anti-universe could help explain the observed matter-antimatter asymmetry in our universe. Cosmological observations show a predominance of matter over antimatter, an asymmetry that remains one of the great mysteries of physics. If antimatter predominates in the anti-universe, this could suggest that the observed asymmetry in our universe is the result of a broader separation of matter and antimatter phases within the context of a larger cosmic structure, involving the fifth dimension as a mediator between these two universes.

From this perspective, the fifth dimension serves not only as a bridge for the universe's expansion into the anti-universe but also as a barrier or separation mechanism that maintains the balance between matter and antimatter in the cosmic whole, preventing their mutual annihilation on a large scale and allowing both the universe and the anti-universe to coexist despite their opposite compositions.

To model the idea that antimatter primarily resides in the anti-universe and interacts with our universe via the fifth dimension, we can consider an equation that represents the conservation of matter and antimatter across the two universes. This equation would take into account the distribution of matter and antimatter as well as the role of the fifth dimension as a mediator of their interaction.

Such an equation could be expressed in the language of field theory, using tensor formalism to describe the distribution of matter (\(\psi_m\)) in our universe and antimatter (\(\psi_a\)) in the anti-universe, along with the fifth dimension (\(x^5\)) as the mechanism of interaction:

$$\Box\psi_m(x^\mu, x^5) + \lambda_m\left|\psi_m(x^\mu, x^5)\right|^2\psi_m(x^\mu, x^5) = -\kappa\psi_a(x^\mu, x^5)$$

\[\Box \psi_m(x^\mu, x^5) + \lambda_m \left| \psi_m(x^\mu, x^5) \right|^2 \psi_m(x^\mu, x^5) = -\kappa \psi_a(x^\mu, x^5) \]

$$\Box\psi_a(x^\mu, x^5) + \lambda_a\left|\psi_a(x^\mu, x^5)\right|^2\psi_a(x^\mu, x^5) = -\kappa\psi_m(x^\mu, x^5)$$

\[\Box \psi_a(x^\mu, x^5) + \lambda_a \left| \psi_a(x^\mu, x^5) \right|^2 \psi_a(x^\mu, x^5) = -\kappa \psi_m(x^\mu, x^5) \]

These equations use the formalism of field theory in a 5-dimensional space to model the interaction between matter in our universe and antimatter in the anti-universe, with the fifth dimension serving as a mediator.

Further Detailing the Distribution of Matter and Antimatter: Mathematical Formalization:

Field Equations for Matter and Antimatter: The interaction between matter and antimatter through the fifth dimension can be modeled by field equations derived from quantum field theory:

$$\Box\psi_m(x^\mu, x^5) + \lambda_m|\psi_m(x^\mu, x^5)|^2\psi_m(x^\mu, x^5) = -\kappa\psi_a(x^\mu, x^5)$$

\[\Box \psi_m(x^\mu, x^5) + \lambda_m |\psi_m(x^\mu, x^5)|^2 \psi_m(x^\mu, x^5) = -\kappa \psi_a(x^\mu, x^5) \]

$$\Box\psi_a(x^\mu, x^5) + \lambda_a|\psi_a(x^\mu, x^5)|^2\psi_a(x^\mu, x^5) = -\kappa\psi_m(x^\mu, x^5)$$

\[\Box \psi_a(x^\mu, x^5) + \lambda_a |\psi_a(x^\mu, x^5)|^2 \psi_a(x^\mu, x^5) = -\kappa \psi_m(x^\mu, x^5) \]

- \(\Box\): Five-dimensional d'Alembert operator

- \(\psi_m(x^\mu, x^5)\): Matter field in the universe

- \(\psi_a(x^\mu, x^5)\): Antimatter field in the anti-universe

- \(\lambda_m\), \(\lambda_a\): Nonlinear coupling constants for matter and antimatter

- \(\kappa\): Coupling constant between matter and antimatter

Conservation Equation:

The conservation equation ensures the conservation of matter and antimatter in each universe:

$$\nabla_\mu J_a^\mu(x) = 0$$

\[\nabla_\mu J^\mu_m(x) = 0 \]

$$\nabla_\mu J_a^\mu(x) = 0$$

\[\nabla_\mu J^\mu_a(x) = 0 \]

- \(J^\mu_m(x)\): Matter current in the universe

- \(J^\mu_a(x)\): Antimatter current in the anti-universe

These equations deepen the understanding of the distribution and interaction between matter and antimatter, considering a fifth dimension as a mediator between the universe and the anti-universe.

Unified Model:

Below is an equation aimed at creating a unified model that integrates the concepts of visible light in our universe, dark light in the anti-universe, and their interaction via a fifth dimension. It proposes a theoretical framework to study how these elements might influence the dynamics of the universe, cosmic expansion, and potentially shed new light on the nature of dark energy.

$$S = \int d^4x\, dr\, \sqrt{-g} \left(\mathcal{L}_{\text{visible}}(\phi_{\text{v}}, g_{\mu\nu}) + \mathcal{L}_{\text{sombre}}(\phi_{\text{s}}, \tilde{g}_{\mu\nu}) + \mathcal{L}_{\text{5D}}(\phi_{\text{v}}, \phi_{\text{s}}, X^4) \right)$$

S = \int d^4x \sqrt{-g} \left(\mathcal{L}_{\text{Visible}}(\phi_v, g_{\mu\nu}) + \mathcal{L}_{\text{Sombre}}(\phi_s, g_{\mu\nu}) + \mathcal{L}_{5D}(\phi_v, \phi_s, X^{4}) \right)

- \(S\) represents the total action of the system.

- \(\int d^4x dr\) denotes the integral over the four-dimensional spacetime and the fifth dimension.

- \(-g\) is the square root of the determinant of the metric tensor of our universe.

- $L_{\text{visible}}(\phi_v, g_{\mu\nu})$ is the Lagrangian describing visible light and its interaction with the spacetime metric $g_{\mu\nu}$.

- $L_{\text{dark}}(\phi_s, \tilde{g}_{\mu\nu})$ is the Lagrangian for dark light in the anti-universe, with $\tilde{g}_{\mu\nu}$ representing the spacetime metric of the anti-universe.

- $L_{\text{5D}}(\phi_v, \phi_s, X_4)$ is an additional Lagrangian that describes the interaction between visible and dark light through the fifth dimension, where X_4 represents the fifth dimension coordinate.

- ϕ_v and ϕ_s are fields representing visible light and dark light, respectively.

Modeling an Extended Universe: The equation attempts to describe a universe not limited to our four-dimensional spacetime but also includes a fifth dimension as well as concepts such as the anti-universe and dark light. This is an attempt to broaden our current understanding of the universe.

Unification of Concepts: It aims to unify ideas like dark light and the anti-universe with elements of standard theoretical physics, such as scalar fields and spacetime metrics.

Foundation for More Complex Theories: This equation could serve as a starting point for the development of more detailed and complex theories. It lays the groundwork for future research and experimentation that could explore these concepts in depth.

Exploration of the Fifth Dimension: Including a fifth dimension opens the possibility of exploring how additional dimensions might influence known physics, particularly in terms of gravity, quantum fields, and the overall structure of the universe.

Research on Dark Energy and Dark Matter: The concepts of dark light and the anti-universe could potentially be linked to current research on dark energy and dark matter, two of the biggest mysteries of modern cosmology.

Inspiration for Experiments and Observations: Although highly theoretical, the equation could inspire experiments or observations aiming to seek evidence of these phenomena.

Unified Field Equations:

$$S = \int d^4x \sqrt{-g} \left(\frac{R}{16\pi G} + \mathcal{L}_{\text{mat}} + \mathcal{L}_{\text{EM}} + \mathcal{L}_{\text{weak}} + \mathcal{L}_{\text{strong}} \right) + \int d^5x \sqrt{-g^{(5)}} \mathcal{L}_{\text{5D}}$$

\[S = \int d^4x \sqrt{-g} \left(\frac{R}{16\pi G} + \mathcal{L}_{\text{mat}} + \mathcal{L}_{\text{EM}} + \mathcal{L}_{\text{weak}} + \mathcal{L}_{\text{strong}} \right) + \int d^5x \sqrt{-g^{(5)}} \mathcal{L}_{\text{5D}} \]

The first term under the first integral is the Einstein-Hilbert action for gravity, where \(R\) is the Ricci scalar, \(G\) is the gravitational constant, and \(g\) is the determinant of the four-dimensional metric tensor.

\(L_{\text{mat}}\) is the Lagrangian describing matter, including fermion fields and their dynamics.

\(L_{\text{EM}}\) is the Lagrangian for electromagnetism, describing electric and magnetic fields.

\(L_{\text{weak}}\) is the Lagrangian for the weak interaction, managing interactions between subatomic particles that are responsible for radioactive decay, among other processes.

\(L_{\text{strong}}\) is the Lagrangian for the strong interaction, which describes how quarks are bound together by gluons to form protons, neutrons, and other hadronic particles.

The second integral adds a contribution from a five-dimensional theory (\(\int d^5x \sqrt{-g^{(5)}} \mathcal{L}_{\text{5D}}\)), where \(g^{(5)}\) is the determinant of the metric tensor in this extended space, and \(\mathcal{L}_{\text{5D}}\) is a Lagrangian that could describe fields or phenomena that exist only in this additional dimension.

This action is an attempt at a unified formulation that encompasses not only the four known fundamental interactions in our four-dimensional universe but also seeks to integrate potential contributions from an additional dimension.

To mathematically formalize the hypothesis encompassing the fifth dimension, dark light, and fundamental interactions, here is a development of the formalism:

a) Omnipresent Light Field:

The modified Klein-Gordon equation for a scalar field \(\Phi\) representing the light field in our universe is given by:

$$(\Box + m^2)\Phi(x) = \mathcal{N}\Phi^3(x) + \mathcal{J}(x).$$

\[(\Box + m^2) \Phi(x) = \mathcal{N} \Phi^3(x) + \mathcal{J}(x) \]

- \(\Box\) is the d'Alembert operator in four-dimensional spacetime.

- \(m\) is the mass of the scalar field \(\Phi\).

- \(\mathcal{N}\) is a nonlinear self-interaction parameter.

- \(\mathcal{J}(x)\) represents an external source, which could model the effects of matter and energy.

b) Fifth Dimension:

The spacetime metric in five dimensions is expressed by:

$$g_{MN} = \text{diag}(-1, 1, 1, 1, \epsilon)$$

\[g_{MN} = \text{diag}(-1, 1, 1, 1, \epsilon) \]

- \(M, N = 0, 1, 2, 3, 4\), where 4 represents the fifth dimension.

- \(\epsilon\) could take the value of 1 or -1, depending on the metric signature chosen for the fifth dimension.

c) Dark Light:

The scalar field \(\Psi(x, y)\) for dark light, including its dynamics in the fifth dimension \(y\), follows:

$$(\Box + m_d^2)\Psi(x, y) = \lambda\Psi^3(x, y) + \Gamma(x, y)$$

\[(\Box + m_d^2) \Psi(x, y) = \lambda \Psi^3(x, y) + \Gamma(x, y) \]

- \(m_d\) is the mass of dark light.

- \(\lambda\) is a nonlinear self-interaction parameter.

- \(\Gamma(x, y)\) represents the interaction of dark light with matter and energy in four-dimensional spacetime.

d) Interaction Between Dimensions:

The interaction term in the action of string theory is:

$$S_{\text{int}} = \int d^{10}X \sqrt{-g} e^{-2\Phi} \left(\alpha \Psi^2 R + \beta (\nabla \Psi)^2 + \gamma e^{\Phi} \Psi^4 \right)$$

\[S_{\text{int}} = \int d^{10}X \sqrt{-g} e^{-2\Phi} \left(\alpha \Psi^2 R + \beta (\nabla \Psi)^2 + \gamma e^{\Phi} \Psi^4 \right) \]

- \(\alpha\), \(\beta\), and \(\gamma\) are coupling constants.

This formalism serves to link concepts of visible light, dark light, and their interaction via an additional dimension in a unified framework. It allows for the mathematical exploration of the implications of these interactions on the structure of spacetime, the

dynamics of the universe, and observable physical phenomena. This opens paths towards a better understanding of dark energy, the expansion of the universe, and the fundamental nature of reality.

Developing a complete quantum field theory (QFT) for dark light requires thorough theoretical considerations and remains an active area of research. Nevertheless, a basic framework can be established to explore this possibility.

Dark Light Scalar Field: Introduce a complex scalar field \(\Psi(x, y)\), where \(x\) represents the four-dimensional coordinates and \(y\) the fifth dimension coordinate. Lagrangian Action: Define a Lagrangian action to describe the dynamics of the field:

$$S = \int d^4x dy \left[\partial_\mu \partial^\mu \Psi(x,y) - m_d^2 |\Psi(x,y)|^2 - \lambda |\Psi(x,y)|^4 + J(x,y)\Psi(x,y)\right].$$

\[S = \int d^4x dy \left[\partial_\mu \partial^\mu \Psi(x, y) - m_d^2 |\Psi(x, y)|^2 - \lambda |\Psi(x, y)|^4 + J(x, y) \Psi(x, y) \right] \]

- \(m_d\): mass of dark light

- \(\lambda\): nonlinear self-interaction constant

- \(J(x, y)\): term coupling dark light to matter and energy in four dimensions

1. Complex Scalar Field \(\Psi(x, y)\): Choosing a complex scalar field allows for incorporating both the phase and amplitude of dark light, offering descriptive richness for modeling phenomena such as interference and coherence, crucial in QFT.

2. Lagrangian Action: The specified Lagrangian provides a basis for calculating the dynamic evolution of the dark light field and its interactions. The presence of quadratic and quartic terms in the action suggests the possibility of nonlinear phenomena and significant self-interactions, potentially analogous to those observed in scalar field theories for cosmic inflation.

Summary:

In this hypothesis, dark light and dark energy are manifestations of the same phenomenon related to the fifth dimension. Dark light, originating from the anti-universe, is of the opposite sign to the visible light of our universe, both interacting through the fifth dimension, which is an omnipresent field. This interaction between the two aspects of light could be responsible for the observed phenomenon of the accelerated expansion of our universe.

We can introduce some notations and conceptual equations to describe these phenomena:

Dynamics of Dark Light in the Fifth Dimension:

$$\Box^{(5)}\Psi + \lambda|\Psi|^2\Psi = -\rho_{\text{ds}}$$

\[\Box^{(5)} \Psi + \lambda |\Psi|^2 \Psi = -\rho_{\text{ds}} \]

Here, \(\Box^{(5)}\) represents the d'Alembert operator in a five-dimensional space, modeling the propagation of dark light \(\Psi\) through the fifth dimension. \(\lambda\) is a nonlinear coupling parameter representing the self-interaction of dark light, and \(\rho_{\text{ds}}\) is a source of dark light, possibly related to the dark energy density in the universe.

Interaction with Our Universe:

$$\partial^\mu F_{\mu\nu} = J_\nu + \kappa \mathcal{I}^{(5)}_\nu(\Psi)$$

\[\partial^\mu F_{\mu\nu} = J_\nu + \kappa \mathcal{I}^{(5)}_{\nu}(\Psi) \]

This equation modifies Maxwell's equations to include an interaction term \(\mathcal{I}^{(5)}_{\nu}(\Psi)\) between dark light in the fifth dimension and the electromagnetic field in our four-dimensional universe. \(\kappa\) is a factor that moderates this interaction.

Dynamics of the Anti-Universe:

The anti-universe could be modeled by a similar equation, but with reversed signs for the source terms or a reversed temporal metric to represent contraction:

$$\Box^{(5)}\Psi_{\text{anti}} - \lambda_{\text{anti}}|\Psi_{\text{anti}}|^2\Psi_{\text{anti}} = \rho_{\text{ds,anti}}$$

\[\Box^{(5)} \Psi_{\text{anti}} - \lambda_{\text{anti}} |\Psi_{\text{anti}}|^2 \Psi_{\text{anti}} = \rho_{\text{ds,anti}} \]

Interaction between the 5th dimension and the other dimensions of space-time

As time does not flow in the 5th dimension to be a present time where all events take place simultaneously in a superimposed manner, we consider in this hypothesis that the 4th dimension derives from the 5th dimension. In other words, the flow of time would be an extension of the present of the 5th dimension.

The conceptual equation I propose to model the idea that the flow of time could be an extension of the "present" in a fifth dimension is as follows:

$$\frac{\partial \Psi}{\partial x^0} = \mathcal{F}\left(\frac{\partial \Psi}{\partial x^4}, \Psi, x^\mu, x^4 \right)$$

\[\frac{\partial \Psi}{\partial x^0} = \mathcal{F}\left(\frac{\partial \Psi}{\partial x^4}, \Psi, x^\mu, x^4 \right) \]

This equation attempts to link the temporal variation of a certain state or field Ψ, which could represent physical entities or conditions of the universe, to its variations in a fifth, non-temporal dimension (x4). Here's what this equation concretely means in this context:

- \(\frac{\partial \Psi}{\partial x^0}\): Represents the partial derivative of the state Ψ with respect to conventional time (x0), i.e., how Ψ changes over time in our daily experience.

- \(\frac{\partial \Psi}{\partial x^4}\): Represents the partial derivative of Ψ with respect to the fifth dimension (x4), illustrating how Ψ changes with variations in this additional dimension.

- \(\mathcal{F}\): Is a function that describes the relationship between these two partial derivatives and potentially other properties of the state Ψ. It models how changes in the fifth dimension affect or are related to the flow of time in our four-dimensional perception.

Interconnection between Time and Fifth Dimension: The equation suggests that the way time flows for us could be influenced or directly derived from processes or properties existing in a fifth dimension. This might mean that the characteristics or dynamics of this additional dimension have a direct impact on our perception of time.

Multidimensional Influence on Reality: Concretely, this opens the possibility that observed phenomena, such as the acceleration of the universe's expansion or certain properties of dark matter and energy, could be the result of interactions or conditions inherent in this fifth dimension.

The mathematical model below aims to explore the hypothesis that the flow of time in our four-dimensional universe stems from a "present" static in an additional fifth dimension.

1. Five-dimensional space-time: Consider a five-dimensional space-time, with coordinates (x0,x1,x2,x3,x4), where x0 represents usual time and x1,x2,x3 spatial dimensions and x4 the additional dimension.

2. "Present" scalar field: Introduce a scalar field Ψ(x0,x1,x2,x3,x4) representing the universe's state at a given moment in the fifth dimension. This field is static in the fifth dimension, i.e., \(\frac{\partial \Psi}{\partial x^4} = 0\).

3. Temporal evolution in lower dimensions: Temporal evolution in our four-dimensional universe is derived from this static "present" in the fifth dimension. To capture this relationship, we propose the following equation:

Ψ / ∂t = F(Ψ, ∇Ψ, ∇^2Ψ, ∇^3Ψ, x^1, x^2, x^3)

\[\frac{\partial \Psi}{\partial t} = F(\Psi, \nabla \Psi, \nabla^2 \Psi, \nabla^3 \Psi, x^1, x^2, x^3) \]

\(\frac{\partial \Psi}{\partial t}\) represents the partial derivative of Ψ with respect to usual time t (i.e., x0), reflecting temporal evolution in our universe.

\(F\) is a nonlinear function capturing the internal dynamics of the field Ψ and its interaction with spatial dimensions. It depends on the field value Ψ, its gradients (\(\nabla \Psi, \nabla^2 \Psi, \nabla^3 \Psi\)), and spatial coordinates (x1,x2,x3).

Interpretation and implications: The equation states that the temporal evolution of the universe's state (represented by Ψ) in our four-dimensional space-time is determined by its "present" static state in the fifth dimension and by the function \(F\) that encodes internal interactions and dynamics.

The function \(F\) can be designed to capture various physical phenomena, such as gravity, electromagnetism, dark matter, and dark energy, and their mutual interactions.

This model provides a mathematical framework to explore the fifth dimension's influence on the universe's expansion, cosmic structure formation, and other observed physical phenomena.

Let's now consider a more complex interaction between dimensions, where the fifth dimension influences not only time but also the other dimensions of space-time, as well as matter and energy. To achieve this, we introduce terms that explicitly model these interactions:

$$\mathcal{L} = \mathcal{L}_{4\mathrm{D}}(\phi, g_{\mu\nu}, F_{\mu\nu}) + \mathcal{L}_{5\mathrm{D}}(\phi, \Psi, g_{\mu\nu}, X^4) + \mathcal{L}_{\mathrm{int}}(\phi, \Psi, g_{\mu\nu}, X^4, F_{\mu\nu})$$

\[\mathcal{L} = \mathcal{L}_{\text{4D}}(\phi, g_{\mu\nu}, F_{\mu\nu}) + \mathcal{L}_{\text{5D}}(\phi, \Psi, g_{\mu\nu}, X^4) + \mathcal{L}_{\text{int}}(\phi, \Psi, g_{\mu\nu}, X^4, F_{\mu\nu}) \]

- \(L_{4D}\): The Lagrangian describing physics in our four-dimensional space-time, including matter (\(\phi\)), the gravitational field (\(g_{\mu\nu}\)), and the electromagnetic field (\(F_{\mu\nu}\)).

- \(L_{5D}\): The Lagrangian for fields in the fifth dimension, where \(\Psi\) represents fields or states specific to this dimension, and \(X^4\) is the coordinate of the fifth dimension.

- \(L_{\text{int}}\): An interaction term modeling how fields in the fifth dimension (\(\Psi\)) interact with matter, energy, and the geometry of space-time in the four dimensions.

- **Space-Time Dynamics**: This model proposes that the structure and dynamics of space-time are directly influenced by processes occurring in the fifth dimension. This could offer new perspectives on gravity, space-time curvature, and the universe's expansion.

- **Matter and Energy**: Interactions between the fifth dimension's fields and matter/energy in our universe could explain some unexplained phenomena, like dark matter, dark energy, or abnormal rates of cosmic expansion.

- **Unification of Forces**: By integrating electromagnetic and gravitational forces within a multidimensional framework, this model could contribute to the efforts of unifying fundamental forces, offering a potential path toward a theory of everything.

Extension of the Model with Field Equations:

Introducing field equations in a five-dimensional space allows us to model the dynamics of matter and energy fields and their interaction with the fifth dimension. Consider the following equations:

$$\Box^{(5)}\phi = -\frac{\delta \mathcal{L}_{\text{int}}}{\delta \bar{\phi}} + \mathcal{S}(\phi, \Psi)$$

\[\Box^{(5)} \phi = -\frac{\delta \mathcal{L}_{\text{int}}}{\delta \bar{\phi}} + \mathcal{S}(\phi, \Psi) \]

$$\Box^{(5)}\Psi = -\frac{\delta \mathcal{L}_{\text{int}}}{\delta \bar{\Psi}} + \mathcal{T}(\phi, \Psi)$$

\[\Box^{(5)} \Psi = -\frac{\delta \mathcal{L}_{\text{int}}}{\delta \bar{\Psi}} + \mathcal{T}(\phi, \Psi) \]

$$G_{\mu\nu}^{(5)} + \Lambda g_{\mu\nu}^{(5)} = 8\pi G \left(T_{\mu\nu}^{(5)} + \Theta_{\mu\nu}(\phi, \Psi) \right)$$

\[G_{\mu\nu}^{(5)} + \Lambda g_{\mu\nu}^{(5)} = 8\pi G \left(T_{\mu\nu}^{(5)} + \Theta_{\mu\nu}(\phi, \Psi) \right) \]

- \(\Box^{(5)} \phi\) and \(\Box^{(5)} \Psi\): Represent the d'Alembert operator in a five-dimensional space acting on the matter field \(\phi\) and the field specific to the fifth dimension \(\Psi\), respectively, illustrating how these fields propagate and interact in the extended space-time.

- \(S(\phi,\Psi)\) and \(T(\phi,\Psi)\): Are terms modeling the specific sources or interactions between the matter field and the fifth dimension field, indicating that these interactions could generate or be affected by properties or phenomena not directly observable within a four-dimensional framework.

- \(G_{\mu\nu}^{(5)}\): Represents the Einstein tensor in a five-dimensional space, showing how the geometry of this extended space-time is affected by the presence of matter, energy, and fields.

This extended model offers a framework to explore in more detail how the fifth dimension might influence not only our perception of time but also the structure of space-time, the distribution and behavior of matter and energy, as well as the fundamental laws governing the universe. It suggests that phenomena such as dark matter and perhaps aspects of quantum mechanics could be linked to complex multidimensional dynamics. Incorporating the idea that dark energy is a component of "dark light" within the framework of a fifth dimension where time is an extension of the omnipresent present, we can adjust or interpret our mathematical models to reflect this relationship. This perspective enriches our understanding of cosmic dynamics and offers avenues for integrating seemingly distinct concepts of dark energy and dark light into a coherent theory. Here's how we might proceed:

Link between Dark Energy and Dark Light: "Dark light" in the fifth dimension can be conceptualized as a manifestation or source of dark energy, which is responsible for the acceleration of the universe's expansion. This relationship can be mathematically expressed by directly linking the state function \

(\Psi\), describing dark light, to effects attributed to dark energy in our four-dimensional space-time.

Modified Equation Incorporating Dark Energy: To explicitly integrate dark energy as a component of dark light in our equations, we could add a term in our model representing the influence of dark light on the space-time metric, indicative of the dark energy effect:

$$\frac{\partial \Psi}{\partial x^0} = \mathcal{F}\left(\frac{\partial \Psi}{\partial x^4}, \Psi, x^\mu, x^4 \right) + \mathcal{E}_{\text{dark}}(\Psi)$$

\[\frac{\partial \Psi}{\partial x^0} = \mathcal{F}\left(\frac{\partial \Psi}{\partial x^4}, \Psi, x^\mu, x^4 \right) + \mathcal{E}_{\text{dark}}(\Psi) \]

Here, \(E_{\text{dark}}(\Psi)\) represents the impact of dark light, conceptualized as a source of dark energy, on the dynamics of four-dimensional space-time.

- **Acceleration of the Universe's Expansion**: Integrating dark energy as a component of dark light in our mathematical model allows us to formulate hypotheses on how variations or properties of the fifth dimension might influence the observed acceleration of the universe's expansion.

- **Unification of Cosmological Concepts**: This approach offers a unified framework for understanding key cosmological phenomena, linking dark energy, dark light, and the multidimensional structure of the universe into a coherent theory that could explain both the nature of dark energy and its role in cosmic expansion.

Recognizing dark energy as a component of dark light within a fifth dimension where the present is omnipresent, we have a basis for exploring deep connections between various cosmological phenomena and the fundamental structure of the universe. This hypothesis prompts a reevaluation of current cosmological models and suggests that understanding the universe's dynamics could benefit from examining properties and interactions in dimensions beyond those we directly perceive.

Interactions Between Dark Light, the Fifth Dimension, and Forces:

To mathematically conceptualize the fifth dimension overlaid on our universe and an anti-universe, and its physical implications, a formulation incorporating this additional dimension into a unified theory is necessary. Here's a simplified equation:

$$ds^2 = (g_{\mu\nu} + \kappa h_{\mu\nu})dx^\mu dx^\nu + \exp(2\phi)(dx^5)^2$$

\[ds^2 = (g_{\mu\nu} + \kappa h_{\mu\nu})dx^\mu dx^\nu + \exp(2\phi) (dx^5)^2 \]

- \(ds^2\): Space-time interval

- \(g_{\mu\nu}\): Metric tensor of four-dimensional space-time

- \(h_{\mu\nu}\): Metric perturbations due to the 5th dimension

- \(\kappa\): Coupling factor determining the influence of the 5th dimension

- \(\phi\): Scalar field modulating the effect of the 5th dimension

- \(dx^\mu, dx^\nu\): Differentials of four-dimensional space-time coordinates

- \(dx^5\): Differential of the 5th dimension coordinate

To mathematically formalize the interactions between dark light, the fifth dimension, and fundamental forces, we can consider a simplified model integrating these concepts within the framework of field theory. This exploratory model will try to

capture the essence of the proposed dynamics and offer a starting point for more complex developments.

- The "dark light" (\(\Psi_{ds}\)) is a field that exists in the fifth dimension (\(x_5\)) and interacts with fields in our four-dimensional space-time.

- The fifth dimension influences fundamental forces via a specific coupling mechanism.

- Fields in our space-time are conventionally represented (e.g., the electromagnetic field by \(A_\mu\), the gravitational field by the metric \(g_{\mu\nu}\), etc.).

Equation for Dark Light:

The dynamics of dark light in the fifth dimension could be described by a modified Klein-Gordon equation to include interactions with matter and other fields in four dimensions.

$$\left(\Box^{(5)} + m_{\text{ds}}^2\right)\Psi_{\text{ds}} = \lambda\Psi_{\text{ds}}\left|\Psi_{\text{ds}}\right|^2 + \kappa J_{\text{int}}$$

\[\left(\Box^{(5)} + m_{\text{ds}}^2 \right) \Psi_{\text{ds}} = \lambda \Psi_{\text{ds}} |\Psi_{\text{ds}}|^2 + \kappa J_{\text{int}} \]

Here, \(\Box^{(5)}\) is the d'Alembert operator in a five-dimensional space-time, \(m_{ds}\) is the mass of the dark light field, \(\lambda\) is the nonlinear coupling parameter (self-interaction of dark light), and \(J_{\text{int}}\) represents the interaction term between dark light and four-dimensional fields, modulated by the coefficient \(\kappa\).

Coupling with Fundamental Forces:

The interaction term \(J_{\text{int, EM}}\) can be defined to reflect the coupling between dark light and fundamental forces, for example, for the electromagnetic field:

$$J_{\text{int, EM}} = \eta F_{\mu\nu}F^{\mu\nu}\Psi_{\text{ds}}$$

\[J_{\text{int, EM}} = \eta F_{\mu\nu} F^{\mu\nu} \Psi_{\text{ds}} \]

where \(F_{\mu\nu}\) is the electromagnetic field tensor, and \(\eta\) is the coupling parameter between dark light and the electromagnetic field.

Influence on Gravity:

The interaction of dark light with the gravitational field could be modeled by modifying the Einstein-Hilbert action to include a term dependent on dark light.

$$S = \int d^5x \sqrt{-g^{(5)}} \left(\frac{R^{(5)}}{16\pi G} + \mathcal{L}_{\text{ds}} + \alpha R^{(5)} \Psi_{\text{ds}}^2 \right)$$

\[S = \int d^5x \sqrt{-g^{(5)}} \left(\frac{R^{(5)}}{16\pi G} + \mathcal{L}_{\text{ds}} + \alpha R^{(5)} \Psi_{\text{ds}}^2 \right) \]

where \(R^{(5)}\) is the Ricci scalar in five-dimensional space-time, \(\mathcal{L}_{\text{ds}}\) is the Lagrangian for dark light, and \(\alpha\) is the coupling parameter between dark light and space-time geometry.

The development of such equations requires deeper exploration to understand the physical implications, coherence conditions, and compatibility with experimental observations. Further studies could include the quantization of these fields, stability analysis of solutions, and exploration of the cosmological consequences of such interactions.

To delve deeper into these equations and make them more rigorous, we can consider several directions, including introducing more complex nonlinear couplings, incorporating specific theories like supersymmetry, or exploring the implications of these interactions on cosmology and particle physics. Here are some approaches to complexify and extend the initial equations:

Non-linear Couplings and More Complex Interactions:

We can introduce more complex nonlinear interactions between dark light and the fields in four dimensions. This can include coupling terms dependent on space-time curvature or interactions mediated by virtual particles:

$$\left(\Box^{(5)} + m_{\text{ds}}^2 + \xi R^{(5)} \right) \Psi_{\text{ds}} = \lambda \Psi_{\text{ds}} |\Psi_{\text{ds}}|^2 + \sum_i \kappa_i \mathcal{O}_i$$

\[\left(\Box^{(5)} + m_{\text{ds}}^2 + \xi R^{(5)} \right) \Psi_{\text{ds}} = \lambda \Psi_{\text{ds}} |\Psi_{\text{ds}}|^2 + \sum_i \kappa_i \mathcal{O}_i \]

Here, \(\xi R^{(5)}\) represents a coupling term between dark light and the curvature of five-dimensional space-time, where \(\xi\) is a coupling coefficient. The \(\kappa_i\) are coefficients for different operators \(\mathcal{O}_i\) representing various interactions with standard fields.

Effects of the Fifth Dimension on Fundamental Forces

The effect of the fifth dimension on fundamental forces can be modeled by introducing modifications to the Lagrangians of electromagnetic, weak, and strong forces, as well as gravity, that account for interactions with the fifth dimension:

$$\mathcal{L}_{\text{force}} = \mathcal{L}_{\text{force, 4D}} + \delta\mathcal{L}_{\text{force, interaction}}(\Psi_{\text{ds}}, g_{AB}, F_{\mu\nu}, \phi)$$

\[\mathcal{L}_{\text{force}} = \mathcal{L}_{\text{force, 4D}} + \delta \mathcal{L}_{\text{force, interaction}}(\Psi_{\text{ds}}, g_{AB}, F_{\mu\nu}, \phi) \]

- "\(\delta \mathcal{L}_{\text{force, interaction}}\)" represents the additional terms due to interactions with dark light and the geometry of the fifth dimension.

Inclusion of Supersymmetry

The introduction of supersymmetry (SUSY) could provide a natural framework to unify interactions between dark light and four-dimensional fields. SUSY could stabilize some vacuum properties and introduce supersymmetric partners that mediate interactions between the fifth dimension and our universe:

$$\mathcal{L}_{\text{SUSY}} = \mathcal{L}_{\text{SUSY, 4D}} + \mathcal{L}_{\text{SUSY, 5D}}(\Psi_{\text{ds}}, \Psi_{\text{SUSY}})$$

\[\mathcal{L}_{\text{SUSY}} = \mathcal{L}_{\text{SUSY, 4D}} + \mathcal{L}_{\text{SUSY, 5D}}(\Psi_{\text{ds}}, \Psi_{\text{SUSY}}) \]

- "\(\mathcal{L}_{\text{SUSY, 5D}}\)" includes supersymmetric interactions involving dark light and its supersymmetric partners.

Cosmology and Inflation

The cosmological implications of interactions between dark light and the fifth dimension, especially regarding inflation and cosmic structure formation, can be explored by integrating these interactions into inflation models:

$$S_{\text{inflation}} = \int d^5x \sqrt{-g^{(5)}} \left(\frac{1}{2} \partial^A \phi \partial_A \phi - V(\phi, \Psi_{\text{ds}}) \right)$$

\[S_{\text{inflation}} = \int d^5x \sqrt{-g^{(5)}} \left(\frac{1}{2} \partial^A \phi \partial_A \phi - V(\phi, \Psi_{\text{ds}}) \right) \]

- Here, \(V(\phi, \Psi_{\text{ds}})\) is an inflation potential that depends on dark light, offering a new mechanism for generating primordial fluctuations.

These extensions require detailed theoretical exploration and precise calculations to fully understand their implications. Each modification or addition increases the model's complexity but can also offer new insights into the structure of the universe and the fundamental laws of physics.

These equations represent key elements in deepening the hypothesis regarding dark light, the fifth dimension, and their interactions with fundamental forces and supersymmetry. They provide a framework for exploring the implications of these concepts on theoretical physics and cosmology more detailedly.

Quantum Field Theory (QFT) of Dark Light:

- **Complex Scalar Field:** Introduction of a complex scalar field Ψ(x,y) for dark light, where x represents four-dimensional coordinates and y represents the fifth dimension.

- **Lagrangian Action:** Definition of a Lagrangian action to describe the dynamics of the field:

$$S = \int d^4x dy[\partial_\mu \partial^\mu \Psi(x,y) - m_d^2|\Psi(x,y)|^2 - \lambda|\Psi(x,y)|^4 + J(x,y)\Psi(x,y)]$$

S = \int d^4x\, d\gamma\, \left[\partial_\mu\psi^*(x, y) \partial^\mu\psi(x, y) - m^2|\psi(x, y)|^2 - \lambda|\psi(x, y)|^4 + J(x, y)\psi(x, y) \right]

- **Field Properties:** The choice of a complex scalar field allows the incorporation of both the phase and amplitude of dark light, offering descriptive richness for modeling phenomena such as interference and coherence, crucial in QFT.

- **Connection with Quantum Field Theory:** The QFT formalism allows for the calculation of probability amplitudes for transitions between different quantum states of dark light and studying its interactions with other quantum fields, such as the electromagnetic field.

Field Equations:

- $(\Box + m^2)\Phi(x) = \mathcal{N}\Phi^3(x) + \mathcal{J}(x)$.**Modified Klein-Gordon Equation:**

\[(\Box + m^2) \Phi(x) = \mathcal{N} \Phi^3(x) + \mathcal{J}(x) \]

- **Dynamics of Dark Light:**

$$\Box^{(5)}\Psi + \lambda|\Psi|^2\Psi = -\rho_{\mathrm{ds}}.$$

\[\Box^{(5)} \Psi + \lambda |\Psi|^2 \Psi = -\rho_{\text{ds}} \]

- **Interaction with Our Universe:**

$$\partial^\mu F_{\mu\nu} = J_\nu + \kappa \mathcal{I}_\nu^{(5)}(\Psi).$$

\[\partial^\mu F_{\mu\nu} = J_\nu + \kappa \mathcal{I}^{(5)}_{\nu}(\Psi) \]

- **Dynamics of the Anti-Universe:**

$$\Box^{(5)}\Psi_{\text{anti}} - \lambda_{\text{anti}}|\Psi_{\text{anti}}|^2\Psi_{\text{anti}} = \rho_{\text{ds,anti}}.$$

\[\Box^{(5)} \Psi_{\text{anti}} - \lambda_{\text{anti}} |\Psi_{\text{anti}}|^2 \Psi_{\text{anti}} = \rho_{\text{ds,anti}} \]

Interconnection Between the 5th Dimension and Other Space-Time Dimensions:

$$\frac{\partial \Psi}{\partial x^0} = \mathcal{F}\left(\frac{\partial \Psi}{\partial x^4}, \Psi, x^\mu, x^4\right).$$

\[\frac{\partial \Psi}{\partial x^0} = \mathcal{F}\left(\frac{\partial \Psi}{\partial x^4}, \Psi, x^\mu, x^4 \right) \]

Complete Lagrangian:

$$\mathcal{L} = \mathcal{L}_{\text{4D}}(\phi, g_{\mu\nu}, F_{\mu\nu}) + \mathcal{L}_{\text{5D}}(\phi, \Psi, g_{\mu\nu}, X^4) + \mathcal{L}_{\text{int}}(\phi, \Psi, g_{\mu\nu}, X^4, F_{\mu\nu}).$$

\[\mathcal{L} = \mathcal{L}_{\text{4D}}(\phi, g_{\mu\nu}, F_{\mu\nu}) + \mathcal{L}_{\text{5D}}(\phi, \Psi, g_{\mu\nu}, X^4) + \mathcal{L}_{\text{int}}(\phi, \Psi, g_{\mu\nu}, X^4, F_{\mu\nu}) \]

Field Equations in a Five-Dimensional Space:

$$\Box^{(5)}\phi = -\frac{\delta \mathcal{L}_{\text{int}}}{\delta \bar{\phi}} + \mathcal{S}(\phi, \Psi).$$

\[\Box^{(5)} \phi = -\frac{\delta \mathcal{L}_{\text{int}}}{\delta \bar{\phi}} + \mathcal{S}(\phi, \Psi) \]

$$\Box^{(5)}\Psi = -\frac{\delta \mathcal{L}_{\text{int}}}{\delta \bar{\Psi}} + \mathcal{T}(\phi, \Psi).$$

\[\Box^{(5)} \Psi = -\frac{\delta \mathcal{L}_{\text{int}}}{\delta \bar{\Psi}} + \mathcal{T}(\phi, \Psi) \]

$$G^{(5)}_{\mu\nu} + \Lambda g^{(5)}_{\mu\nu} = 8\pi G\left(T^{(5)}_{\mu\nu} + \Theta_{\mu\nu}(\phi, \Psi)\right).$$

\[G_{\mu\nu}^{(5)} + \Lambda g_{\mu\nu}^{(5)} = 8\pi G \left(T_{\mu\nu}^{(5)} + \Theta_{\mu\nu}(\phi, \Psi) \right) \]

Link Between Dark Energy and Dark Light:

$$\frac{\partial \Psi}{\partial x^0} = \mathcal{F}\left(\frac{\partial \Psi}{\partial x^4}, \Psi, x^\mu, x^4\right) + \mathcal{E}_{\text{dark}}(\Psi).$$

\[\frac{\partial \Psi}{\partial x^0} = \mathcal{F}\left(\frac{\partial \Psi}{\partial x^4}, \Psi, x^\mu, x^4 \right) + \mathcal{E}_{\text{dark}}(\Psi) \]

These equations represent an attempt to mathematically formalize the complex interactions between dark light, dark energy, the universe and the anti-universe, while considering the fifth dimension as a fundamental element of these dynamics. They provide a basis for future investigations into the nature of dark light, its role in the expansion of the universe, and its links with fundamental forces and matter/antimatter. This theoretical framework could pave the way for new discoveries in cosmology, particle physics, and quantum field theory, thereby enriching our understanding of the universe at a fundamental level.

A complete and detailed formalization of a quantum field theory (QFT) for dark light, based on the previously introduced mathematical concepts.

- **Quantized Scalar Field for Dark Light**: Define a quantized complex scalar field \(\hat{\Psi}(x,y)\), where \(x\) represents four-dimensional coordinates and \(y\) the coordinate of the fifth dimension.

- **Field Operator \(\hat{\Psi}(x,y)\)** satisfies the canonical commutation relations:

$$[\hat{\Psi}(x,y), \hat{\Psi}^\dagger(x',y')] = i\hbar\delta^{(4)}(x-x')\delta(y-y')$$

\[[\hat{\Psi}(x,y), \hat{\Psi}^{\dagger}(x',y')] = i\hbar \delta^{(4)}(x-x')\delta(y-y') \]

- **Vacuum State**: $\hat{\Psi}(x,y)|\Omega\rangle = 0$

\[\hat{\Psi}(x,y)|\Omega\rangle = 0 \]

- **Quantum Lagrangian**: Define a quantum Lagrangian for dark light:

$$\mathcal{L} = \partial_\mu\hat{\Psi}^\dagger(x,y)\partial^\mu\hat{\Psi}(x,y) - m_d^2\hat{\Psi}^\dagger(x,y)\hat{\Psi}(x,y) - \frac{\lambda}{2}(\hat{\Psi}^\dagger(x,y)\hat{\Psi}(x,y))^2 + \hat{J}(x,y)\hat{\Psi}^\dagger(x,y) + \hat{J}^\dagger(x,y)\hat{\Psi}(x,y)$$

\[\mathcal{L} = \partial_{\mu} \hat{\Psi}^{\dagger}(x,y) \partial^{\mu} \hat{\Psi}(x,y) - m_{d}^2 \hat{\Psi}^{\dagger}(x,y) \hat{\Psi}(x,y) - \frac{\lambda}{2} (\hat{\Psi}^{\dagger}(x,y) \hat{\Psi}(x,y))^2 + \hat{J}(x,y) \hat{\Psi}^{\dagger}(x,y) + \hat{J}^{\dagger}(x,y) \hat{\Psi}(x,y) \]

\(\hat{J}(x,y)\) is a current operator representing the interaction of dark light with matter and energy in four dimensions.

- **Quantum Klein-Gordon Equation**: The quantum Klein-Gordon equation for the field \(\hat{\Psi}(x,y)\) is:

$$(-\Box + m_d^2 - \lambda \hat{\Psi}^\dagger(x,y)\hat{\Psi}(x,y))\hat{\Psi}(x,y) = \hat{J}(x,y)$$

\[(-\Box + m_{d}^2 - \lambda \hat{\Psi}^{\dagger}(x,y) \hat{\Psi}(x,y)) \hat{\Psi}(x,y) = \hat{J}(x,y) \]

- **Dark Light Propagator**: The dark light propagator \(D(x,y;x',y')\) is the solution of the quantum Klein-Gordon equation with a point source:

$$(-\Box + m_d^2 - \lambda \hat{\Psi}^\dagger(x,y)\hat{\Psi}(x,y))D(x,y;x',y') = \delta^{(4)}(x-x')\delta(y-y')$$

\[(-\Box + m_{d}^2 - \lambda \hat{\Psi}^{\dagger}(x,y) \hat{\Psi}(x,y))D(x,y;x',y') = \delta^{(4)}(x-x')\delta(y-y') \]

The propagator allows calculation of the probability amplitude for a dark light particle to propagate from one point \((x,y)\) to another point \((x',y')\).

- **Interactions with Matter and Energy**: The interaction of dark light with matter and energy is described by the current operator \(\hat{J}(x,y)\).

The form of \(\hat{J}(x,y)\) depends on the specific model of interaction. Examples of interactions include:

- Coupling to a scalar matter field: \(\hat{J}(x,y) = g\phi(x) \hat{\Psi}(x,y)\)

$$\hat{J}(x,y) = g\phi(x)\hat{\Psi}(x,y)$$

- Coupling to an electromagnetic field: \(\hat{J}(x,y) = e\gamma^{\mu} A_{\mu}(x) \hat{\Psi}(x,y)\) $\hat{J}(x,y) = e\gamma^\mu A_\mu(x)\hat{\Psi}(x,y)$

- **Perturbative Calculations**: The formal framework for perturbative calculations is not easily summarized by a single equation, as it generally involves a series of expansions in terms of perturbation theory based on the interaction Lagrangian. However, the general approach is represented by the Dyson series for the S-matrix, expressed as:

$$S = T\exp\left(-i\int d^4x \mathcal{L}_{\text{interaction}}\right)$$

$$ S = T \exp\left(-i \int d^4x \mathcal{L}_{\text{interaction}}\right) $$

where T is the time-ordering operator, and $\mathcal{L}_{\text{interaction}}$ is the interaction part of the Lagrangian.

These elements form the foundation of a quantum field theory for dark light, allowing for detailed analysis of the properties and interactions of this hypothetical field.

String Theory and Loop Quantum Gravity:

The ideas presented in this hypothesis, exploring concepts like the fifth dimension, dark light, and interactions between our universe and an anti-universe, can complement and fit within broader discussions on string theory and loop quantum gravity. Here's how these ideas might integrate and potentially enrich these theories:

String Theory

1. **Additional Dimensions**: String theory postulates the existence of extra dimensions beyond the four we perceive. Introducing your fifth dimension could be seen as a specific exploration of these additional dimensions, providing a framework for their physical characterization and cosmological implications.

2. **Unification of Forces**: String theory aims to unify all the fundamental forces of nature by describing elementary particles not as points, but as "strings" vibrating. The interaction between visible light, dark light, and the fifth dimension could provide mechanisms by which these vibrations manifest or are modulated, offering new avenues to explore force unification.

3. **Dark Energy and Dark Matter**: String theory has the potential to offer explanations for dark matter and dark energy. Your concept of dark light as a manifestation of dark energy in a fifth dimension could be integrated within the string framework, potentially as a specific state or vibration of strings in this extra dimension.

Loop Quantum Gravity

1. **Quantization of Space-Time**: Loop quantum gravity proposes a theory where space-time itself is quantized. The idea of a pervasive fifth dimension could fit within this framework by providing a model to understand how these space-time quanta behave or interact beyond the usual four dimensions.

2. **Unification and Complementarity**: Although loop quantum gravity primarily focuses on the quantization of gravity and does not necessarily postulate extra dimensions like string theory, your hypothesis could offer a point of complementarity, proposing mechanisms through which the quantum effects of gravity interact with additional dimensions.

3. **Implications for Time and the Universe's Structure**: The notion of an "eternal present" in the fifth dimension could provide interesting insights into the nature of time in loop quantum gravity, where time is an emergent concept rather than a fundamental parameter.

To create a mathematical formalism unifying string theory and loop quantum gravity (LQG) with the hypothesis of the fifth dimension and concepts of dark light, we need to integrate these ideas into a coherent framework. The goal is to formulate equations that capture the dynamics of strings and loops in the presence of a fifth dimension and dark light, while respecting the fundamental principles of each theory. Here is a proposed approach:

1. **Extension of Space-Time and Strings**

- **String Theory with the Fifth Dimension**:

$$S_{\text{cordes}} = \int d^{10}X \sqrt{-g} e^{-2\Phi} \left(R + 4(\nabla \Phi)^2 - \frac{1}{12} H^2 + \ldots \right)$$

- \(S_{\text{strings}} = \int d^{10}X \sqrt{-g} e^{-2\Phi} \left(R + 4(\nabla \Phi)^2 - \frac{1}{12}H^2 + \ldots \right)\)

- Add a term that explicitly represents the effects of dark light in the fifth dimension \(X^5\) and its interaction with the dilaton field \(\Phi\).

2. **Quantization of Gravity**

- **Loop Quantum Gravity with Fifth Dimension**:

$$H_{\text{GQB}} = \sum_{\text{boucles}} E_{\text{boucle}} \delta(\text{boucle}, \text{espace-temps à 5D})$$

- \(H_{\text{LQG}} = \sum_{\text{loops}} E_{\text{loop}} \delta(\text{loop}, \text{5D space-time})\)

- \(E_{\text{loop}}\) represents the energy of loops or spin networks, extended to include contributions from the fifth dimension.

3. **Unification of Forces and Dark Light**

- **Forces-Dark Light Interaction**:

$$\mathcal{L}_{\text{int}} = \int d^4x \sqrt{-g} \left(F_{\mu\nu}F^{\mu\nu} + \Psi_{\text{ds}} \mathcal{O}(\Phi, A_\mu, \psi) \right)$$

- $\mathcal{L}_{\text{int}} = \int d^4x \sqrt{-g} \left(F_{\mu\nu}F^{\mu\nu} + \Psi_{\text{ds}} \mathcal{O}(\Phi, A_\mu, \psi) \right)$

- $F_{\mu\nu}$ is the electromagnetic field tensor, Ψ_{ds} is the field representing dark light, and $\mathcal{O}$ is an operator describing the interactions between dark light and other fields in the four-dimensional space-time as well as their extensions into the fifth dimension.

4. **Dynamics of Dark Light and Cosmological Effects**

- **Field Equation for Dark Light**:

$$\Box \Psi_{\text{ds}} + m^2 \Psi_{\text{ds}} = \lambda |\Psi_{\text{ds}}|^2 \Psi_{\text{ds}} + \Gamma \mathcal{I}(\Psi_{\text{ds}}, \text{matière}, \text{gravité})$$

- $\Box \Psi_{\text{ds}} + m^2 \Psi_{\text{ds}} = \lambda |\Psi_{\text{ds}}|^2 \Psi_{\text{ds}} + \Gamma \mathcal{I}(\Psi_{\text{ds}}, \text{matter}, \text{gravity})$

- m is the mass of the dark light field, λ is the self-interaction parameter, and Γ is a coupling factor between dark light and matter/gravity.

5. **Implications for the Universe's Structure**

- **Cosmological Modifications**:

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = 8\pi G \left(T_{\mu\nu} + T_{\mu\nu}^{\text{ds}} \right)$$

- $G_{\mu\nu} + \Lambda g_{\mu\nu} = 8\pi G (T_{\mu\nu} + T_{\mu\nu}^{\text{ds}})$

- $G_{\mu\nu}$ is the Einstein tensor, Λ is the cosmological constant modified to include the effects of dark light, $T_{\mu\nu}$ is the matter energy-momentum tensor, and $T_{\mu\nu}^{\text{ds}}$ represents contributions from dark light.

These equations represent an attempt at a unified formulation that accounts for both the principles of string theory and loop quantum gravity while integrating the concepts of the fifth dimension and dark light. This approach requires advanced mathematical developments and could lead to new experimental predictions that would help to test the validity of this unified theory. The success of this endeavor could offer a new understanding of the universe, its fundamental forces, and its large-scale structure, linking concepts that, until now, were treated separately in theoretical physics.

To explicitly integrate the effects of dark light within the fifth dimension (X5) and its interaction with the dilaton field (Φ), we could consider adding an interaction term in the action of string theory. This term should capture how dark light, conceptualized as a scalar field or a set of fields within the fifth dimension, influences and is influenced by the dilaton. Here is an example of a term that could represent this interaction:

$$S_{\text{int}} = \int d^{10}X \sqrt{-g}\, e^{-2\Phi} \left(\alpha\, \Psi_{\text{ds}}^2\, R + \beta\, (\nabla \Psi_{\text{ds}})^2 + \gamma\, e^{\Phi}\, \Psi_{\text{ds}}^4 \right)$$

\[S_{\text{int}} = \int d^{10}X \sqrt{-g} \, e^{-2\Phi} \left(\alpha \, \Psi_{\text{ds}}^2 \, R + \beta \, (\nabla \Psi_{\text{ds}})^2 + \gamma \, e^{\Phi} \, \Psi_{\text{ds}}^4 \right)\]

- \(S_{\text{int}}\) represents the action of interaction specific to the effect of dark light and its interaction with the dilaton field.

- \(d^{10}X\) and \(\sqrt{-g}\) indicate integration over the 10-dimensional space-time and the square root of the determinant of the space-time metric, respectively.

- \(e^{-2\Phi}\) reflects the action's dependence on the dilaton field, thus modulating the interaction based on the dilaton's value.

- \(\Psi_{\text{ds}}\) is the field representing dark light in the fifth dimension.

- \(R\) is the Ricci scalar, representing the curvature of space-time.

- \(\alpha\), \(\beta\), and \(\gamma\) are coupling constants quantifying the intensity of interactions between dark light and the dilaton field, as well as the self-interaction of dark light.

- \((\nabla \Psi_{\text{ds}})^2\) represents the covariant derivative of the dark light field, indicating how this field varies in space-time.

- \(e^{\Phi} \Psi_{\text{ds}}^4\) introduces a non-linear term representing potentially strong self-interactions of dark light, modulated by the dilaton field.

This interaction term is designed to capture the complex dynamics between dark light and the dilaton field, while accounting for the effects of space-time curvature and the

spatial variations of dark light. It offers a framework to explore how the presence of dark light in the fifth dimension might influence the geometry of space-time through the dilaton field and vice versa, thus providing a potential pathway to study the cosmological and physical effects of these interactions.

The goal would be to construct a theory that not only accurately describes cosmological and subatomic observations but also offers new testable predictions about the nature of space-time, fundamental forces, and dark matter and energy. This interdisciplinary work could potentially lead to a better understanding of the universe at all scales, unifying ideas from string theory, loop quantum gravity, and your hypothesis in a coherent framework.

What Can This Hypothesis Answer?

Acceleration of Universe Expansion: The observation that the universe is accelerating in its expansion remains one of the biggest enigmas of modern cosmology. This hypothesis, by associating this acceleration with the interaction between dark light (dark energy) and the fifth dimension, proposes a new way to understand the source of this cosmic repulsion.

Nature of Dark Energy: The nature of dark energy, which constitutes about 68% of the universe, remains largely unknown. By conceptualizing dark energy as a manifestation of dark light in a fifth dimension, this hypothesis offers a new framework to study its properties and influence on the universe's expansion.

Dark Matter: Dark matter is another mysterious component of the universe, detectable only through its gravitational effects. Although this hypothesis primarily focuses on dark light and dark energy, the introduction of a fifth dimension could also provide new ways to understand the distribution and behavior of dark matter, suggesting, for example, gravitational interactions or other forces acting through this additional dimension.

Quantum Superposition and Entanglement: Quantum phenomena of superposition and entanglement, which defy classical intuition, could be influenced by the existence of a fifth dimension where the properties of matter and energy are non-local and omnipresent. This could open new perspectives on the fundamental nature of quantum reality.

Matter-Antimatter Asymmetry: The predominance of matter over antimatter in the observable universe poses a fundamental question. The idea of an anti-universe interacting with our universe through a fifth dimension could potentially provide a context for exploring the mechanisms of this asymmetry.

Cosmological Constant: The value of the cosmological constant Λ, which plays a key role in the standard model of cosmology, is difficult to reconcile with predictions from quantum field theory. The hypothesis of a fifth dimension could offer new approaches

to understanding and integrating the cosmological constant into theories of gravity and dark energy.

Unification of Gravity and Quantum Forces: The quest for a theory of everything, which unifies general relativity (describing gravity) and quantum mechanics (describing the other three fundamental forces), is a major goal of physics. By proposing a fifth dimension as a framework for these interactions, this hypothesis offers a new way to conceive unification, potentially resolving the incompatibilities between these two theories by introducing a space where their effects could coexist or be related coherently.

Role of Dark Light and Dark Energy: By associating dark energy with dark light and placing it within the context of a fifth dimension, this hypothesis suggests that what has been perceived as two distinct entities (dark matter/energy and fundamental forces) could be linked through a more fundamental structure of the universe. This could help integrate dark energy, a repulsive force on a large scale, into the framework of fundamental interactions.

Exploration of the Fifth Dimension: The proposal of a fifth dimension opens the possibility to explore fields and particles not observed in the usual four spacetime dimensions. This additional dimension could be the domain where gravitational and quantum forces interact or transform into each other, offering a mechanism for unification.

Anti-Universe and Symmetry: The idea of an anti-universe interacting with our universe through a fifth dimension could introduce a fundamental symmetry between matter and antimatter, as well as between gravitational and quantum forces. This symmetry could be crucial for understanding the unified nature of fundamental forces and the overall structure of the universe.

Variations of Fundamental Constants: Observations have suggested that some fundamental physical constants might vary across the universe. If these variations were confirmed, they could be explained by dynamic interactions or modulations through the fifth dimension, affecting different regions of the universe differently.

Fluctuations in the Cosmic Microwave Background (CMB): Fluctuations observed in the CMB could be influenced by prior or ongoing interactions with the anti-universe, mediated by the fifth dimension. This could help explain some of the statistical anomalies or patterns observed that do not fully match standard cosmological models.

Large-Scale Structure of the Universe: Unexpected behaviors in galaxy rotation or in the distribution of intergalactic matter could be reexamined in light of this hypothesis, considering how forces or fields through the fifth dimension could influence these phenomena.

Time and Its Perception: By suggesting that the fifth dimension influences our perception of time, transforming our linear understanding into a more holistic view where time could be an extension of an "eternal present", it challenges and expands our understanding of time itself.

What Technology Could This Hypothesis Bring?

The hypothesis exploring the fifth dimension and the notion of dark light offers fertile ground for potential technological innovations in several areas. Here are some technological innovations that this hypothesis could inspire:

1. **Communication Through the Fifth Dimension**

   - **Instantaneous Communication**: By leveraging the fifth dimension as a mediator, it might be possible to develop communication technologies that surpass the limits of the speed of light in our four-dimensional spacetime, allowing for instant transmission of information across vast distances.

2. **Propulsion and Space Travel**

   - **Extra-Dimensional Engines**: Understanding the dynamics of the fifth dimension could lead to the development of new forms of space propulsion, using principles of manipulating this dimension for faster-than-light travel or instant jumps across space.

   - **Intergalactic Portals**: The fifth dimension could provide a framework for creating stabilized "portals" or "wormholes", allowing for instant travel between distant points in the universe.

3. **Energy Generation**

   - **Harnessing Dark Light**: If dark light is a form of energy with unique properties, understanding and exploiting it could pave the way for new, potentially revolutionary energy sources to power future technologies.

4. **Detectors of Higher Dimensions**

   - **Advanced Instrumentation**: The development of detectors capable of directly or indirectly observing the effects of the fifth dimension or dark light could transform our ability to observe the universe and uncover previously invisible phenomena.

5. **Cooling and Matter Manipulation Technologies**

   - **Exploiting Negative Properties**: Manipulating the negative energy properties associated with dark light could lead to new cooling technologies or methods of manipulating matter at the quantum or cosmic scale.

6. **Multidimensional Simulation and Modeling**

- **Advanced Software**: Software capable of simulating the universe while accounting for additional dimensions could enhance our understanding of cosmic, climatic, geological, and biological phenomena, offering more accurate predictions and more complex models.

7. **Information Storage Technologies**

- **Storage in the Fifth Dimension**: Using the unique properties of the fifth dimension, it might be possible to develop ultra-dense data storage methods, far surpassing the capabilities of current technologies.

These innovations, while speculative at this stage, highlight the potential impact of such a hypothesis on future science and technology. The path to realizing these technologies will require thorough exploration of the fundamental principles of the hypothesis, accompanied by significant breakthroughs in theoretical and experimental physics.

Conclusion:

These approaches could provide fertile ground for conceptual explorations in physics. We have attempted to create a cosmological model that addresses observations such as the universe's expansion, dark energy, quantum superposition, quantum entanglement, etc., by integrating a fifth dimension to bridge the visible and invisible.

The fifth dimension, conceptualized as a dimension of light encompassing both positive and negative aspects (visible and dark light), provides a unified framework for examining the fundamental interactions of nature. This approach could allow for the unification of descriptions of cosmic phenomena, governed by general relativity, with those of quantum mechanics, two areas of physics that remain largely distinct within current frameworks.

By associating dark energy with "dark light" in this fifth dimension, this model offers a new interpretation of the repulsive force accelerating the universe's expansion. This perspective could provide insights into the nature and origin of dark energy, linking it directly to the intrinsic properties of the fifth dimension.

Quantum superposition and entanglement, phenomena where particles exhibit simultaneous states and instant connections despite distances, could be influenced or modulated by interactions with the fifth dimension. This might suggest that these quantum phenomena, often considered manifestations of non-locality, are actually the result of a more complex multidimensional structure of the universe.

The hypothesis presented is an ambitious and conceptually rich exploration attempting to link various cosmological and fundamental phenomena through the introduction of concepts such as "dark light," a fifth dimension characterized by an infinite present, and a dynamic interaction between our universe and an anti-universe. This hypothesis not only proposes to rethink our understanding of the

universe and its most mysterious components but also aims to establish the foundations of a unified theory of physics. Here is an expanded and detailed summary of this hypothesis and its implications:

Key Concepts of the Hypothesis

1. **Omnipresent Light Field**: Light is envisioned as an omnipresent field, where photons move at a constant speed, but the field itself is perceived as existing everywhere, offering a new perspective on the nature and propagation of light.

2. **Fifth Dimension**: Proposes the existence of an additional dimension transcending linear time, in which all events coexist. This dimension would play a central role in linking physical phenomena, allowing the transformation of visible light into "dark light" and vice versa.

3. **Dark Light**: Postulates the existence of an undetectable form of light with negative energy properties, which could interact with matter and energy in an unprecedented way, potentially related to dark energy.

4. **Universe and Anti-Universe**: Suggests a dynamic where our universe and an anti-universe alternate between expansion and contraction, implying symmetry and an exchange of energy or information through the fifth dimension.

Towards a Unified Theory

This hypothesis aims to provide a path toward a unified theory of physics that integrates multidimensional interactions, non-linear phenomena, and concepts of dark light and dark energy, in a coherent framework capable of explaining the cosmological mysteries unresolved by current models.

Implications and Perspectives

- **Theoretical Physics and Cosmology**: Offers an innovative framework for integrating phenomena such as the acceleration of the universe's expansion, the nature of dark matter and dark energy, and other unexplained observations, into a broader understanding of the universe's structure and dynamics.

- **Detection and Experimentation Challenges**: Raises the need to develop new methods to detect dark light and observe the effects of the fifth dimension, potentially leading to technological and methodological advancements.

- **Unification of Physical Theories**: Encourages exploration of ways to harmonize this hypothesis with the principles of general relativity and quantum mechanics, in search of a more unified and encompassing theory of everything.

By proposing links between such vast and fundamental concepts, this hypothesis seeks not only to explain some of the universe's greatest mysteries but also aspires to establish a basis for a unified theory that could revolutionize our understanding of physics. Although it presents significant theoretical and experimental challenges, this exploration opens promising avenues for future research in theoretical physics and cosmology.

Continuity of the Hypothesis

Development of Experimental and Observational Approaches

- **Experimental Proposals**: Design specific experiments, for example using particle accelerators or cosmological observatories, to test the predictions of the hypothesis, including the presence and effects of the fifth dimension.

- **Astronomical and Cosmological Observations**: Utilize telescopes and satellites to search for signatures of the fifth dimension or effects of dark light in the large-scale structure of the universe, cosmic radiation, or gravitational anomalies.

Simulations and Numerical Modelling

- **Development of Advanced Simulations**: Create sophisticated numerical models to simulate the universe taking into account the contributions of the fifth dimension and dark light, in order to observe their influence on the formation of cosmic structures and the evolution of the universe.

- **Big Data Analysis**: Leverage advanced data analysis techniques to examine vast sets of astronomical data for patterns or anomalies that could indicate the effects of the fifth dimension.

Hypothesis on "Dark Light" Extension

This extension is a continuation of the "Hypothesis on Light," aiming to define the context in which the fifth dimension operates to perform light transformations in the anti-universe.

Black Holes as Dimensional Interfaces:

In this model, black holes are not merely extreme gravitational objects but also serve as interfaces between dimensions. They capture matter and energy from our universe (visible matter and light) and, instead of confining them indefinitely, transform them into dark light, a form of energy that can cross the dimensional barrier to the anti-universe.

Transformation Process:

1. **Absorption and Conversion**: Matter and light absorbed by a black hole are subjected to extreme conditions of gravity and energy density. Under these conditions, and in the presence of the fifth dimension, matter and visible light undergo a fundamental transformation, converted into dark light.

2. **Transmission through the Fifth Dimension**: Once transformed, this dark light is not confined by the black hole's event horizon in the same way as ordinary matter. Thanks to unique properties related to the fifth dimension, it can traverse this horizon and be transmitted to the anti-universe.

3. **Role of the Fifth Dimension**: The fifth dimension functions as a conduit or transmission mechanism, allowing dark light not only to escape the black hole's singularity but also to cross the dimensional barrier separating our universe from the anti-universe.

4. **Unification of Cosmological Phenomena**: This hypothesis provides a framework to unify various cosmological phenomena, such as black holes, dark energy, and the multidimensional structure of the universe, into a coherent theory.

In the process of transforming matter into energy within a black hole, a portion of this energy could be emitted into the anti-universe as dark light. This phenomenon could be analogous to the evaporation of black holes predicted by Hawking, but with dark light particles being emitted instead of ordinary matter particles.

The effects of the fifth dimension around black holes could be indirectly observable through cosmological phenomena, such as gravitational lensing, the distribution of dark matter, or specific spectral signatures emanating from regions with high black hole activity.

Integrating the idea that the anti-universe contracts while our universe expands, with black holes playing a key role in this process, adds an additional layer of complexity and symmetry to the hypothesis. Here's how this dynamic could be conceptualized:

Mechanism of Contraction and Expansion:

1. **Energy Exchange via Black Holes**: Black holes absorb matter and visible light from our universe, transforming them into dark light through a process involving the fifth dimension. This dark light is then transmitted to the anti-universe, where it exerts an opposite influence to that observed in our universe.

2. **Role of Dark Light in the Anti-Universe**: Instead of contributing to expansion, as is the case in our universe, dark light would act as a factor of contraction in the anti-universe. This could be due to an inversion of dark light properties when it crosses the fifth dimension, or to the opposite nature of matter and energy in the anti-universe, which reacts differently to this form of energy.

3. **Conservation of Energy Across Universes**: This mechanism suggests a form of energy conservation or symmetry at the cosmic scale. Energy absorbed and transformed by black holes in our universe fuels expansion, while its equivalent transferred to the anti-universe contributes to its contraction, maintaining a balance between the two universes.

Implications and Perspectives:

- **Symmetry Between Universe and Anti-Universe**: This hypothesis emphasizes a fundamental symmetry between our universe and the anti-universe, where physical processes may have opposite but related effects, reflecting a more integrated cosmic structure and dynamics.

- **Nature of Dark Light**: The transformation of visible light into dark light and its potentially different role in the anti-universe could offer new insights into the nature of dark energy and its behavior in different cosmological contexts.

- **Search for Observable Evidence**: To support this hypothesis, it would be crucial to search for observable evidence of the effects of dark light and its influence on the dynamics of the universe, as well as indications of the presence and properties of the anti-universe.

- **Expanded Cosmological Theories**: This model could stimulate the development of expanded cosmological theories that incorporate the dynamics of multiple universes or additional dimensions, offering new frameworks to understand the universe.

Incorporating black holes as mechanisms of transformation and energy transfer between our universe and the anti-universe, this hypothesis proposes a deeply interconnected cosmological model, where the forces of expansion and contraction reflect a dynamic balance on the scale of the entire universe.

1. Fifth Dimension Formalism

Definition of the Metric: Begin by defining a metric for five-dimensional spacetime that incorporates the fifth dimension coherently with general relativity.

$$ds^2 = g_{\mu\nu}dx^\mu dx^\nu + \epsilon e^{2\phi(x)}(dx^5)^2$$

\[ds^2 = g_{\mu\nu}dx^\mu dx^\nu + \epsilon e^{2\phi(x)}(dx^5)^2\]

where \(g_{\mu\nu}\) is the metric tensor of four-dimensional spacetime, \(\phi(x)\) is a scalar field representing the potential of the fifth dimension, and \(\epsilon\) determines the signature of the fifth dimension.

2. Dark Light Dynamics

Field Equation for Dark Light: Formulate an equation that describes the dynamics of dark light in the fifth dimension, taking into account its interaction with matter and energy in the four dimensions.

$$(\Box + m_{ds}^2)\Psi_{ds} = \lambda|\Psi_{ds}|^2\Psi_{ds} + \text{Terme d'interaction}$$

\[(\Box + m^2_{ds})\Psi_{ds} = \lambda |\Psi_{ds}|^2\Psi_{ds} + \text{Interaction Term}\]

3. Interaction between Universes via Black Holes

Modeling Black Holes as Portals: We postulate that matter and energy absorbed by a black hole in our universe are converted into dark light, which is then emitted into the anti-universe, contributing to its contraction while fueling the expansion of our universe. This transformation and transmission could be mediated by the fifth dimension.

$$\frac{\partial}{\partial x^5} E_{\text{visible}} = -\Gamma\left(E_{\text{absorbée}}\right) + E_{\text{sombre}}(x^5)$$

\[\frac{\partial}{\partial x^5} E_{\text{visible}} = -\Gamma \left(E_{\text{absorbed}} \right) + E_{\text{dark}}(x^5)\]

\(\frac{\partial}{\partial x^5} E_{\text{visible}}\) represents the differential transformation of the visible energy/matter absorbed by the black hole as a function of the fifth dimension \(x^5\).

\(\Gamma(E_{\text{absorbed}})\) is a conversion function that describes the process by which the visible energy/matter absorbed is transformed into dark light, where \(\Gamma\) is a conversion coefficient that could depend on several factors, including the properties of the black hole and the characteristics of the fifth dimension.

\(E_{\text{dark}}(x^5)\) denotes the resulting dark energy (or dark light) in the fifth dimension, contributing to the expansion of our universe and the contraction of the anti-universe.

This equation is a simplification and would require further development to accurately incorporate the underlying physical mechanisms and principles of energy conservation. It aims to conceptually illustrate how interactions via black holes and the fifth dimension could be modeled within the framework of this hypothesis.

4. Energy Conservation and Universe Dynamics

Principle of Conservation: The following equation could represent the conservation of energy between our universe and the anti-universe, involving energy transformation via the fifth dimension and black holes:

$$\Delta E_{\text{univers}} + \Delta E_{\text{anti-univers}} + \Delta E_{\text{5D}} = 0$$

\[\Delta E_{\text{universe}} + \Delta E_{\text{anti-universe}} + \Delta E_{\text{5D}} = 0\]

\(\Delta E_{\text{universe}}\) represents the change in energy in our universe due to the absorption of matter and energy by black holes and their transformation into dark light.

\(\Delta E_{\text{anti-universe}}\) is the change in energy in the anti-universe, where the energy emitted as dark light contributes to its contraction.

\(\Delta E_{\text{5D}}\) corresponds to the energy transformed and/or transported through the fifth dimension, serving as a transfer mechanism between the universes.

This equation expresses the principle that the total energy involved in the interactions between the universes, including transformations and transfer via the fifth dimension, remains constant, thus respecting the law of conservation of energy on a multidimensional scale.

5. Cosmological Implications

Equations Modifying Standard Cosmology: Let's incorporate the effects of the fifth dimension and dark light into the standard cosmology equations, such as the Friedmann equations, to study their implications on the universe's expansion and dark energy. Modifying the Friedmann equations to incorporate the effect of the fifth dimension could look something like this:

$$H^2 + \frac{k}{a^2} = \frac{8\pi G}{3}\rho + \frac{\Lambda}{3} + \frac{\sigma}{a^4} + \frac{\epsilon}{a^2}\Psi_{\text{ds}}$$

\[H^2 + \frac{k}{a^2} = \frac{8 \pi G}{3} \rho + \frac{\Lambda}{3} + \frac{\sigma}{a^4} + \frac{\epsilon}{a^2} \Psi_{\text{ds}}\]

- \(H\) is the Hubble parameter, describing the rate of expansion of the universe.

- \(k\) represents the spatial curvature of the universe, where \(k=-1,0,+1\) for an open, flat, or closed universe, respectively.

- \(a\) is the scale factor of the universe, describing how distances in the universe change over time.

- \(G\) is Newton's gravitational constant.

- \(\rho\) is the average density of matter and energy in the universe.

- \(\Lambda\) is the cosmological constant, often associated with dark energy in standard cosmology.

- \(\sigma\) is a radiation term, including the effect of visible light and other forms of radiation.

- \(\epsilon\) is a parameter introduced to model the impact of the fifth dimension on the universe's expansion.

- \(\Psi_{\text{ds}}\) represents the effect of dark light (dark energy) acting through the fifth dimension.

This equation attempts to capture the additional complexity introduced by the presence of the fifth dimension and dark light, allowing for a richer description of cosmological dynamics. It suggests that the influence of the fifth dimension and dark light could manifest as an additional contribution to the Friedmann equation, thus influencing the universe's rate of expansion.

6. Interaction with Matter and Antimatter

Field Equations for Matter/Antimatter: To model the interactions of matter and antimatter with the fifth dimension in the context of this hypothesis, we can consider a field equation that describes how matter in our universe and antimatter in the anti-universe are influenced by this additional dimension. Here is a proposed field equation for matter (\(\psi_m\)) and antimatter (\(\psi_a\)), incorporating the impact of the fifth dimension (represented by \(x^5\)):

$$\Box\psi_m(x^\mu, x^5) + \mu_m^2\psi_m(x^\mu, x^5) = \lambda_m|\psi_m(x^\mu, x^5)|^2\psi_m(x^\mu, x^5) + \kappa_m\mathcal{F}(x^5, \psi_a),$$
$$\Box\psi_a(x^\mu, x^5) + \mu_a^2\psi_a(x^\mu, x^5) = \lambda_a|\psi_a(x^\mu, x^5)|^2\psi_a(x^\mu, x^5) + \kappa_a\mathcal{F}(x^5, \psi_m).$$

\begin{align}

\Box \psi_m(x^\mu, x^5) + \mu_m^2 \psi_m(x^\mu, x^5) &= \lambda_m |\psi_m(x^\mu, x^5)|^2 \psi_m(x^\mu, x^5) + \kappa_m \mathcal{F}(x^5, \psi_a), \\

\Box \psi_a(x^\mu, x^5) + \mu_a^2 \psi_a(x^\mu, x^5) &= \lambda_a |\psi_a(x^\mu, x^5)|^2 \psi_a(x^\mu, x^5) + \kappa_a \mathcal{F}(x^5, \psi_m).

\end{align}

- \(x^\mu\) represents the coordinates of four-dimensional spacetime.

- \(x^5\) is the coordinate of the fifth dimension.

- \(\Box\) is the d'Alembert operator, acting on the fields in four-dimensional spacetime plus the fifth dimension.

- \(\psi_m\) and \(\psi_a\) are the matter and antimatter fields, respectively.

- \(\mu_m^2\) and \(\mu_a^2\) are the squared masses of these fields, determining their dynamics.

- \(\lambda_m\) and \(\lambda_a\) are coupling constants, representing the self-interaction of the matter and antimatter fields.

- \(\kappa_m\) and \(\kappa_a\) are coupling constants representing the interaction between matter and antimatter through the fifth dimension.

- \(\mathcal{F}(x^5, \psi)\) is a generic function that models the effect of the fifth dimension on the matter and antimatter fields, possibly including direct interactions or effects modulated by this additional dimension.

These equations aim to formalize the idea that matter and antimatter in our universe and the anti-universe are connected and potentially modified by the presence and properties of the fifth dimension, offering a way to explore the complex dynamics between these components of the universe.

To explicitly enhance the hypothesis of black holes as dimensional interfaces and the interactions between our universe and the anti-universe through the fifth dimension, here is a formal proposal of key equations that could be included in a rigorous mathematical development of the scientific article:

Interaction Equation between Visible Light and Dark Light:

$$\mathcal{L}_{\text{int}} = -g^2(\Phi\Psi)^2$$

\mathcal{L}_{\text{int}} = -g^2(\Phi \Psi)^2

This equation models the interaction between visible light (\(\Phi\)) and dark light (\(\Psi\)) in the fifth dimension, with \(g\) representing the coupling constant between these two fields.

Evolution Equation for the Scalar Field Representing Dark Light:

$$(\Box + m^2)\Psi + V(\Phi)\Psi = 0$$

(\Box + m^2)\Psi + V(\Phi)\Psi = 0

This equation describes the dynamics of dark light \(\Psi\) in five-dimensional spacetime, where \(\Box\) is the d'Alembert operator, \(m\) is the mass of the dark light field, and \(V(\Phi)\) represents the interaction potential with visible light.

Energy Conservation Equation for Dark Light:

$$\partial_\mu J^\mu = 0$$

\partial_\mu J^\mu = 0

This ensures energy conservation in interactions between visible and dark light, where \(J^\mu\) is the energy current associated with dark light.

Einstein-Hilbert Equation in Five Dimensions:

$$R_{MN} - \frac{1}{2}Rg_{MN} + \Lambda g_{MN} = 8\pi G T_{MN}$$

R_{MN} - \frac{1}{2}Rg_{MN} + \Lambda g_{MN} = 8\pi G T_{MN}

This equation generalizes Einstein's equations to a five-dimensional spacetime, including the curvature caused by matter and energy, where \(R_{MN}\) is the Ricci tensor, \(R\) the Ricci scalar, \(g_{MN}\) the metric tensor, \(\Lambda\) the cosmological constant, and \(T_{MN}\) the five-dimensional energy-momentum tensor.

Coupling Equations between Matter and Antimatter Fields and the Fifth Dimension:

$$\mathcal{L}_m = -\frac{1}{2}(\partial_\mu \psi)^2 - \frac{1}{2}m^2\psi^2 - \lambda(\psi^4) + \kappa\psi\mathcal{F}$$

\mathcal{L}_m = -\frac{1}{2}(\partial_\mu\psi)^2 - \frac{1}{2}m^2\psi^2 - \lambda(\psi^4) + \kappa\psi\mathcal{F}

This describes the interaction between matter (\(\psi\)) and the fifth dimension, with \(\lambda\) and \(\kappa\) representing the coupling constants, and \(F\) a function of the fifth dimension.

Each of these equations contributes significantly to modeling the complex phenomena related to the hypothesis, offering a mathematical framework to explore the implications of the fifth dimension and dark light in cosmology and particle physics.

General Thoughts on the Hypothesis:

The idea that black holes could serve as interfaces between different dimensions is fascinating and fits into a broader quest for a deeper understanding of the universe's fundamental structure. This hypothesis could offer a new perspective on the nature of black holes, traditionally viewed as end-stage objects in stellar evolution, and their role in cosmology and theoretical physics.

1. **Specific Energy Signatures:**

Specific energy signatures could include radiation spectra emitted by regions surrounding black holes that do not match the predictions of current models of accretion disks or relativistic jets. These spectra might show abnormal frequencies or intensities suggesting the existence of unknown energetic processes, potentially related to the transformation of matter into dark light. Detecting such anomalies would likely require instruments capable of measuring radiation across a wide range of wavelengths, from radio waves to gamma rays.

2. **Suggestions for Experiments or Observations:**

An experimental approach could involve monitoring known black holes for particle emissions or radiation that cannot be explained by standard theories. Space missions equipped with detectors sensitive to a broad spectrum of electromagnetic frequencies could be particularly useful. Additionally, international collaborations like the Event Horizon Telescope, which captured the first image of a black hole, could be expanded to search for evidence of dimensional interactions. Advanced computer simulations based on the hypothesis could also help predict specific phenomena to look for.

3. **Implications for the Nature of Time and Space:**

If the hypothesis is correct, it could suggest that our current understanding of time and space is incomplete. The concept of a fifth dimension providing a mechanism for energy transformation and communication between universes could imply that time and space are not fixed entities but rather aspects of a more complex and dynamic structure of the universe. This could lead to new physics that integrates time and space in a nonlinear manner, potentially paving the way for unified theories of quantum gravity.

To enhance the hypothesis of black holes as dimensional interfaces and deepen the understanding of the involved processes, several additional equations can be considered. These equations should allow for a more detailed exploration of transformation mechanisms, energy conservation, and interactions between dimensions. Here are some proposed additional equations:

Field Equation for the Fifth Dimension:

To describe how the fifth dimension influences matter and energy, a generalized field equation could be formulated.

$$\Box^{(5)}\phi + V(\phi) = \kappa \mathcal{L}_{\text{matière}},$$

\Box^{(5)} \phi + V(\phi) = \kappa \mathcal{L}_{\text{matter}},

where \(\Box^{(5)}\) represents the d'Alembert operator in five-dimensional spacetime, \(\phi\) is the scalar field associated with the fifth dimension, \(V(\phi)\) a potential of the scalar field, and \(\kappa \mathcal{L}_{\text{matter}}\) the coupling term between the fifth dimension and the matter/energy of the universe.

Energy-Matter Conversion Equation:

To model the conversion of matter and energy absorbed by black holes into dark light.

$$\frac{dE_{\text{sombre}}}{dt} = \eta \Gamma(E_{\text{absorbée}}),$$

\frac{dE_{\text{dark}}}{dt} = \eta \Gamma(E_{\text{absorbed}}),

where \(\eta\) is a conversion efficiency coefficient and \(\Gamma(E_{\text{absorbed}})\) represents the conversion function.

Energy Conservation Equation in the Fifth Dimension:

To ensure global energy conservation during transmission between dimensions.

$$\nabla_\mu T^{\mu\nu}_{(5)} = 0,$$

\nabla_\mu T^{\mu\nu}_{(5)} = 0,

where \(T^{\mu\nu}_{(5)}\) represents the energy-momentum tensor in five-dimensional spacetime, highlighting the importance of energy conservation even during dimensional transitions.

Equation for the Anti-Universe Dynamics:

To explore how dark energy (dark light) affects the anti-universe.

$$\Box^{(5)}\Psi_{\text{anti}} = -\lambda_{\text{anti}}|\Psi_{\text{anti}}|^2\Psi_{\text{anti}} + S_{\text{sombre}},$$

\Box^{(5)} \Psi_{\text{anti}} = -\lambda_{\text{anti}} |\Psi_{\text{anti}}|^2 \Psi_{\text{anti}} + S_{\text{dark}},

where \(\Psi_{\text{anti}}\) represents a field in the anti-universe, \(\lambda_{\text{anti}}\) a coupling constant for self-interaction in the anti-universe, and \(S_{\text{dark}}\) a source term from the transmitted dark energy.

These additional equations aim to provide a more complete framework for understanding the complex interactions between our universe, the fifth dimension, and the anti-universe, focusing on transformation processes and energy conservation. They could also help formulate testable predictions that could be explored through cosmological observations or particle physics experiments.

To mathematically formalize the process of dark light emission by black holes, akin to Hawking evaporation but with a mechanism extended to the fifth dimension and emission into the anti-universe, we can consider an equation that combines quantum field theory in curved spaces with concepts from string theory or loop quantum gravity. This formalization could revolve around the field equation for a scalar field in curved spacetime, while introducing additional terms to model the interaction with the fifth dimension and conversion into dark light.

However, it's important to note that creating such an equation requires significant theoretical extension and falls within an advanced domain of theoretical physics research. Here's an outline of what such an equation might look like:

General Equation for Dark Light Emission

The modified Hawking equation for a scalar field \(\Psi\) in curved spacetime with a fifth dimension might be presented as follows:

$$(\Box - m^2 - \xi R)\Psi = S(\Psi, \Phi, g_{\mu\nu}, g_{55})$$

(\Box - m^2 - \xi R)\Psi = S(\Psi, \Phi, g_{\mu\nu}, g_{55})

where:

- \(\Box\) is the d'Alembert operator in curved spacetime,

- \(m\) is the mass of the scalar field,

- \(\xi\) is a non-minimal coupling factor describing the field's interaction with the spacetime scalar curvature \(R\),

- \(\Psi\) is the scalar field representing dark light,

- \(S(\Psi, \Phi, g_{\mu\nu}, g_{55})\) is a source term modeling the interaction of dark light with visible light (\(\Phi\)), the four-dimensional spacetime metric \(g_{\mu\nu}\), and the metric associated with the fifth dimension \(g_{55}\).

This source term \(S\) could include contributions such as:

- The conversion of absorbed matter and energy by the black hole into dark light,

- The effects of the fifth dimension on the propagation of dark light,

- The emission of dark light into the anti-universe through the fifth dimension.

Additional Considerations

- **Interaction with the Fifth Dimension**: The manner in which dark light interacts with the fifth dimension and is emitted into the anti-universe requires a detailed description of this additional dimension's properties, which could be modeled through an extension of existing theories such as string theory or loop quantum gravity.

To formalize energy conservation within the context of black holes serving as dimensional interfaces, especially during the transformation of matter and energy into dark light and their transfer between our universe and the anti-universe, we can employ the generalized principle of energy-momentum conservation in a multidimensional spacetime. This approach will account for the total energy, including contributions from visible matter, dark light, and energy associated with the fifth dimension.

Here is an equation that encapsulates energy conservation in this framework:

$$\nabla_\mu T^{\mu\nu} + \nabla_5 T^{5\nu} = 0$$

\nabla_\mu T^{\mu\nu} + \nabla_5 T^{5\nu} = 0

where:

- ∇μ is the covariant differentiation symbol in four-dimensional spacetime,

- Tμv is the energy-momentum tensor in four-dimensional spacetime, representing the distribution of energy and momentum of matter and fields, including visible light,

- ∇5 is the covariant differentiation along the fifth dimension,

- T5v is a component of the energy-momentum tensor describing the contribution from the fifth dimension, including effects of dark light and potentially other forms of energy associated with this dimension.

This equation expresses that the divergence of the energy-momentum tensor in our four-dimensional universe and in the fifth dimension is zero, meaning that the total energy (including contributions from all dimensions) is conserved. It encapsulates the idea that although energy may be transferred between dimensions (e.g., from four-dimensional spacetime to the fifth dimension as dark light), the total amount of energy in the overall system remains constant.

The hypothesis of black holes as dimensional interfaces is promising for several reasons:

1. **Explanatory Potential:**

   - Offers a possible explanation for the accelerated expansion of the universe by introducing dark energy as dark light.

   - Proposes a mechanism for the creation of dark matter from ordinary matter absorbed by black holes.

   - Provides a framework for exploring interactions between universes and additional dimensions.

2. **Consistency with Observations:**

   - Some aspects of the hypothesis, like the transformation of matter into energy and the transmission of energy through black holes, are consistent with astrophysical observations.

   - Predicted signatures, such as anomalies in the radiation spectra around black holes, could be detectable with advanced instruments.

3. **Link with Fundamental Theories:**

   - The hypothesis can be connected to fundamental theories like string theory or loop quantum gravity, contributing to unifying our understanding of physics.

4. **Stimulus for New Research:**

   - Stimulates new research in theoretical physics, cosmology, and astrophysics to explore the hypothesis's implications and test it experimentally.

However, it's important to emphasize that the hypothesis is at a preliminary stage and faces significant challenges:

- **Lack of Experimental Evidence**: The existence of the fifth dimension and dark light has not yet been confirmed.

- **Mathematical Complexity**: The analysis and validation of the hypothesis require advanced mathematical developments and numerical simulations.

- **Implications for Future Technologies**: If such mechanisms of energy transformation and dimensional interaction were understood, it could have far-reaching implications for new technologies, perhaps even for energy or space travel.

In conclusion, while the hypothesis is promising and stimulating for scientific imagination, it rests on theoretical foundations that require much more profound exploration and experimental validation. Like any new theory in physics, its acceptance will depend on its ability to predict new phenomena and withstand rigorous experimental tests.

Source :

- **Green, Michael B., John H. Schwarz, et Edward Witten**, "Superstring Theory" (Cambridge University Press) : Un texte de référence sur la théorie des cordes, qui introduit l'idée de dimensions supplémentaires.
- **Becker, Katrin, Melanie Becker, et John H. Schwarz**, "String Theory and M-Theory: A Modern Introduction" (Cambridge University Press) : Fournit une introduction à la théorie des cordes et à la théorie M, y compris la discussion des dimensions supplémentaires.
- **Carroll, Sean M**., "Spacetime and Geometry: An Introduction to General Relativity" (Addison-Wesley) : Offre un aperçu de la relativité générale et des trous noirs.
- **Frolov, Valeri P., et Igor D. Novikov**, "Black Hole Physics: Basic Concepts and New Developments" (Kluwer Academic Publishers) : Discute de la physique des trous noirs, y compris des concepts avancés.
- **Bertone, Gianfranco**, "Particle Dark Matter: Observations, Models and Searches" (Cambridge University Press) : Couvre divers aspects de la matière noire, y compris les modèles théoriques et les observations.
- **Peebles, P. J. E**., "Principles of Physical Cosmology" (Princeton University Press) : Une ressource sur la cosmologie qui inclut des discussions sur l'énergie sombre.
- **Rovelli, Carlo**, "Reality Is Not What It Seems: The Journey to Quantum Gravity" (Riverhead Books) : Bien que se concentrant sur la gravité quantique, ce livre explore également des idées qui pourraient être reliées à l'existence de dimensions supplémentaires.
- **https://arxiv.org/abs/1402.3952v2**
- **https://arxiv.org/abs/2312.02084v1**
- **Kaluza, T. (1921).** "Zum Unitätsproblem der Physik." Sitzungsber. Preuss. Akad. Wiss. Berlin. (Math. Phys.), 1921: 966-972.
    - **Pourquoi :** Introduction originale de l'idée d'une cinquième dimension dans un cadre unifié de la gravité et de l'électromagnétisme.
- **Klein, O. (1926).** "Quantentheorie und fünfdimensionale Relativitätstheorie." Zeitschrift für Physik A Hadrons and Nuclei 37, no. 12 (1926): 895-906.
    - **Pourquoi :** Fondement de la réduction de la cinquième dimension de Kaluza-Klein, essentiel pour comprendre l'intégration de dimensions supplémentaires en physique.
- **Randall, L., & Sundrum, R. (1999).** "Large Mass Hierarchy from a Small Extra Dimension." Physical Review Letters, 83(17), 3370.

    - **Pourquoi :** Présente un modèle avec des dimensions supplémentaires pour expliquer pourquoi la gravité est faible par rapport aux autres forces fondamentales.
- **Carroll, S. M. (2001).** "The cosmological constant." Living Reviews in Relativity, 4(1), 1.
    - **Pourquoi :** Revue complète sur la constante cosmologique et l'énergie sombre, pertinent pour les discussions sur l'accélération de l'expansion de l'univers.
- **Rovelli, C. (2008).** "Loop Quantum Gravity." Living Reviews in Relativity, 11(1), 5.
    - **Pourquoi :** Introduction accessible à la gravité quantique à boucles, utile pour discuter des fondements quantiques de la gravité et des dimensions.
- **Green, B., Schwarz, J.H., & Witten, E. (1987).** "Superstring Theory." Cambridge University Press.
    - **Pourquoi :** Texte fondamental sur la théorie des cordes, couvrant les principes de base et les développements théoriques.
- **Weinberg, S. (1989).** "The Cosmological Constant Problem." Reviews of Modern Physics, 61(1), 1-23.
    - **Pourquoi :** Discussion approfondie sur les défis posés par la constante cosmologique, essentielle pour les théories cosmologiques modernes.
- **Maldacena, J. (1998).** "The Large N limit of superconformal field theories and supergravity." International journal of theoretical physics 38.4: 1113-1133.
    - **Pourquoi :** Introduction de la correspondance AdS/CFT, un outil puissant pour étudier les théories des champs et la gravité quantique.
- **Riess, A. G., et al. (1998).** "Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant." The Astronomical Journal, 116(3), 1009.
    - **Pourquoi :** Observation clé soutenant l'accélération de l'expansion de l'univers, fondamentale pour les discussions sur l'énergie sombre.
- **Preskill, J., Schwarz, P., Shapere, A., Trivedi, S., & Wilczek, F. (1991).** "Limitations on the statistical description of black holes." Modern Physics Letters A, 6(24), 2353-2362.
    - **Pourquoi :** Examine les implications des trous noirs sur la théorie quantique des champs et la gravité, pertinent pour les discussions sur la matière noire et la lumière sombre.