

Spherical Model of the Universe (SMU)

An Alternative Cosmological Approach Based on General Relativity

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Abstract

I present a new cosmological model – the Spherical Model of the Universe (SMU) – as an alternative to the standard Λ CDM paradigm. The model is based on the premise of a finite and causally closed universe with spherical topology, where spacetime is an immanent property of matter and energy. Spacetime is not a separate substance, but a structure that reflects the distribution and motion of energy and matter. It has no existence on its own; its geometry and topology are expressions of the presence of matter. The SMU assumes strict energy conservation within the External Event Horizon (EEH). Redshift is interpreted not as a consequence of space expansion, but as a cumulative gravitational redshift. The model introduces a cyclic evolution of the universe, the concept of quantum-coherent informational dynamics, and offers a new interpretation of dark matter and dark energy.

Keywords: cosmology, general relativity, redshift, quantum gravity, quarks, law of conservation of energy, entropy, dark matter, dark energy

1 Introduction

Standard cosmology heavily relies on the concept of universal (cosmic) time and expanding space. In contrast, the SMU rejects the notion of global cosmic time and understands redshift not as metric stretching, but as a consequence of gravitational energy exchange during a photon's trajectory.

We construct a geometrically closed universe with an External Event Horizon (EEH), which is a dynamically evolving boundary beyond which spacetime loses physical meaning. This is not a classical barrier, but a metric boundary for the existence of space and time themselves.

In conventional cosmology, an existing cosmic time – a universal timeline independent of gravitational fields or observer motion – is implicitly assumed, which directly contradicts the principle of relativity of simultaneity.

- **Relativity of Simultaneity:** Simultaneity is not an absolute concept.

- **Spacetime Unification:** Space and time form a unified whole.
- **Gravity as Geometry:** $g_{\mu\nu} = \frac{c^4}{8\pi G} \cdot T_{\mu\nu}$

1.1 SMU Emphasizes Local Atomic Processes as the True Physical Measure of Time

Cosmic time originated as a computational tool in a homogeneous and isotropic model. The concept of cosmic time arose as a useful computational tool in a highly symmetric model of the universe (FLRW metric) [3], [7], [9], [10]. However, its introduction does not mean that it has a physical existence outside of this model. In the SMU, abstract "cosmic time" does not exist; there is only causal connection and a sequence of events. Time is only local. The basis of time measurements are real physical processes, for example, the oscillation period of cesium atoms, which defines the second. These local processes, influenced by gravitational potential, provide a natural and physically consistent measure of time. An observer's proper time, measured by their own clocks, is always relevant for their observations and experiments. This approach is consistent with the equivalence principle – a fundamental pillar of general relativity.

$$d\tau = \sqrt{-g_{\mu\nu} \cdot dx^\mu \cdot dx^\nu} \quad (\text{proper time}) \quad (1)$$

1.2 How Then to Define Cosmic Distances and Time? CMB 13.8 Billion Years?

In the SMU, we must abandon conventional ideas of cosmic distances and time.

Λ CDM Approach:

- CMB = 13.8 billion years of "light travel time" in expanding space.
- Distant galaxies = redshift \rightarrow distance via Hubble's constant.
- Assumption of a homogeneous metric.

SMU Reality:

- Metric changes along the entire photon path.
- Dynamic spacetime with gravitational waves.
- "Negative energy" affects expansion.

2 Geometric of the Universe

2.1 Geometric Structure of the Spherical Universe

The FLRW metric in the SMU is replaced by the geometry of a closed three-dimensional sphere (3-sphere). A local observer perceives space as approximately flat, while the global structure of the universe is curved and finite.

Standard Flat Metric:

$$ds^2 = -c^2 dt^2 + a^2(t)[dr^2 + r^2(d\theta^2 + \sin^2 \theta d\phi^2)] \quad (2)$$

Spherical Transformation $r \leftrightarrow \chi$: We introduce a transformation between the common radial coordinate r and the angular coordinate χ , which corresponds to the parametrization of a 3-sphere:

$$r = R(t) \cdot \sin \chi, \quad \chi \in [0, \pi] \quad (3)$$

$$\chi = \arcsin\left(\frac{r}{R(t)}\right) \quad (4)$$

This ensures that space is finite and curved, with $\chi = 0$ corresponding to the "center" and $\chi = \pi$ to the boundary of the universe (EEH). The metric then describes a 3-sphere embedded in a 4-dimensional Euclidean space. For an internal observer, space appears locally flat and potentially infinite. Globally, however, the system contains a boundary (EEH) beyond which one cannot proceed.

2.2 External Event Horizon

The boundary of the universe is defined as the External Event Horizon (EEH).

The EEH represents a fundamental boundary of spacetime, where spacetime is locally extended into the entire sphere of the universe. Unlike a black hole horizon, it is not a barrier preventing escape from within, but defines an absolute boundary of spacetime existence beyond which spacetime loses physical meaning. An external view of such a universe is merely a fiction, an idea, with no physical basis. At the EEH, the gravitational potential approaches zero, and the gravitational gradient approaches zero (reaching Planck limits). Beyond this boundary, there simply is no further space or time. The EEH is not a static boundary. It evolves dynamically depending on changes in the internal arrangement of matter and energy. A local observer perceives no boundary. For an object moving towards the EEH, its motion would appear extremely accelerated from the perspective of a distant observer, the metric extremely stretched, and continuation beyond spacetime would thus not be possible. Beyond this boundary, no further spatial dimension exists.

We, as internal observers, are unable to directly target or observe this spherical boundary. The only thing that mediates it to us is the cosmic microwave background (CMB), which represents the return of photons from this boundary. "Return" is not a classical reflection, but a consequence of the impossibility of crossing this metric boundary. It is important to realize that, unlike the Λ CDM model, redshift in the SMU does not express the distance of objects.

$$R_{EEH} = c \int_0^\infty a(t) dt = \text{finite value} \quad (5)$$

Although the CMB appears isotropic at a macroscopic level, small anisotropies in temperature (at the level of $\sim 10^{-5}$) bear the imprint of the global geometry of the universe. The SMU assumes that these anisotropies, among other things, arose as interference during the return of photons from the EEH, with small spatial curvatures and movements of matter affecting their backshift. This could explain some observed multipole anomalies in the CMB spectrum [1].

2.3 Critical Ratio Derived from the Schwarzschild Radius $G/2$

I propose an alternative approach to understanding the formation of the event horizon, based on the ratio of gravitational potentials in isolated systems. The traditional description of the event horizon focuses on the Schwarzschild radius, $R_S = \frac{2GM}{c^2}$, as an absolute property of an object. However, this approach does not take into account the gravitational environment in which the observer is located. I therefore suggest a perspective based on the relative ratio of gravitational potentials within an isolated system.

The critical ratio is derived from the calculation of the Schwarzschild radius

At the surface of the body ($r = R$):

$$G_2 = \frac{GM}{R}$$

At the Schwarzschild radius ($r = R_S$):

$$G_1 = \frac{GM}{R_S} = \frac{GM}{2GM/c^2} = \frac{c^2}{2}$$

The ratio is thus:

$$\frac{G_1}{G_2} = \frac{c^2/2}{GM/R} = \frac{c^2 R}{2GM}$$

For a body with a density close to the critical density of a black hole, $R \approx R_S$, so $G_1/G_2 \approx 1/2$.

The event horizon forms at a distance where the local gravitational potential reaches half the surface potential observed for that object ($G_1/G_2 = 1/2$), providing a universal

criterion independent of the specific masses of the objects involved.

Non-Isolated Systems – Multiple Gravitational Sources

The total potential is given by:

$$\phi_{\text{total}} = \phi_1 + \phi_2 + \phi_3 + \dots$$

The event horizon does not manifest if other sources “mask” the effect. Therefore, the event horizon is not an absolute property of an object but depends on the gravitational background, the observer’s position within the total gravitational field, and the mass and energy structure of the surrounding environment.

The ratio $G_1/G_2 = 1/2$ is independent of the object’s mass M , the mass of the observer, and the specific size of the object. It depends solely on the geometry of the situation and the structure of the gravitational field.

3 Quantum Analysis of Photon Behavior at the EEH (External Event Horizon)

3.1 Physical Context of the Problem

In the SMU model, the External Event Horizon (EEH) is a fundamental metric boundary of spacetime, characterized by the following conditions:

- The gravitational potential is maximally "smoothed out" ($\nabla\Phi \rightarrow 0$).
- The metric approaches Planck limits.
- No further space or time can be defined beyond this boundary.

3.2 QuantumMechanical Analysis

3.2.1 Heisenberg Uncertainty Relations at the EEH

If a photon reaches the EEH boundary, its position is limiting (approaching infinite momentum smearing) ($\Delta x \rightarrow 0$), which according to the Heisenberg relation implies $\Delta p \rightarrow \infty$.

This means extreme momentum uncertainty and thus a high degree of quantum state blurring. A photon therefore cannot classically "touch" the boundary, but rather exists as a quantum superposition in its vicinity.

3.2.2 Energy Limits

A photon cannot be "destroyed", it must preserve its quantum existence. At the EEH, it possesses:

- Minimum Planck energy: $E_{\min} = \hbar\omega_{\text{Planck}}$
- Planck frequency: $\omega_{\text{Planck}} = \sqrt{\frac{c^5}{\hbar G}} \approx 1.85 \times 10^{43}$ Hz
- Planck wavelength: $\lambda_{\text{Planck}} = \sqrt{\frac{\hbar G}{c^3}} \approx 1.6 \times 10^{-35}$ m

3.3 Mechanism of "Reflection" at the EEH

3.3.1 Quantum Reflection

At the boundary of spacetime (EEH), a phenomenon occurs which we call the Planck barrier, a limiting interface that a photon cannot cross. This barrier is quantum-mechanically and geometrically derivable as an effective potential:

$$V_{\text{eff}}(r) = \omega^2 \left(1 - \frac{r_c^2}{2GM} \right) + \frac{2}{r^2} \frac{l(l+1)\hbar^2}{c^2} \quad (6)$$

$$f(x) = (1 + e^{-x})^{-1} \text{ [sigmoid]} \text{ or } f(x) = (1 + x^2)^{-1} \text{ [Lorentzian]} \quad (7)$$

The reflection of a photon at the spacetime boundary is not classical, but quantum—it is a quantum reflection with a high reflection coefficient $R \approx 1$. The photon never crosses the EEH, but exists as a quantum-blurred superposition of states in the vicinity of the boundary.

Quantum Reflection Coefficient:

$$R(E) = |r(E)|^2 \text{ where } r(E) \text{ is the complex reflection amplitude.} \quad (8)$$

Wave Function at the Boundary: Quantum state of the photon:

$$\psi(r) = A \cdot e^{ikr} + B \cdot e^{-ikr} \quad \text{for } r < R_{EEH} \quad (9)$$

$$\psi(r) = C \cdot e^{-\kappa r} \quad \text{for } r > R_{EEH} \quad (10)$$

$$k = \frac{\omega}{c} = \frac{E}{\hbar c} \quad \text{for a free photon} \quad (11)$$

$$\kappa = \sqrt{\frac{V_{\text{eff}}(r) - \omega^2}{c^2}} \quad \text{in a gravitational field} \quad (12)$$

Once the photon reaches this value, it no longer has any energy potential to transfer via gravity; kinetic energy equals potential energy. It is at the upper turning point of the system. Through this mechanism, the photon is in the position of creating the external spacetime horizon, the EEH, which is not some fixed level but individual for each photon depending on its energy. The boundary of spacetime is not absolute, but an emergent

property dependent on the observer/particle; the informational density of the system approaches zero at this extreme boundary.

Physical Logic:

- Gravity, according to Einstein, curves spacetime based on energy-matter.
- Information in quantum mechanics is physically real (it has energy).
- Ergo: $G(r) \propto \rho_{\text{info}}(r)$

Consequences for the EEH when a photon reaches the quantum minimum

$E \rightarrow E_{\text{min}}$:

- $k \rightarrow k_{\text{min}} = \frac{E_{\text{min}}}{hc} = 0$
- $\kappa \rightarrow 0$
- $R \rightarrow 0$ (almost no reflection)
- $T \rightarrow 0$ (almost no tunneling)

The photon "gets stuck" at the EEH at a quantum minimum, but does not completely cease to exist. Spacetime "almost closes" but not completely.

Einstein's Field Equation $G_{\mu\nu} = 8\pi GT_{\mu\nu}$ And $T_{\mu\nu}$ already contains informational content, because: $T_{\mu\nu} = \text{energy-matter density tensor} = \text{quantum density tensor} = \text{informational density tensor}$

Physical Interpretation:

- Gravity is not influenced by information.
- Gravity IS a manifestation of the informational structure of matter/energy.
- Spacetime curvature = geometrical manifestation of quantum information.

For the EEH model: When $G(r) \rightarrow 0$, it's not because "information disappears," but because energy/matter has reached a quantum minimum. The informational content is minimal because the energetic content is minimal.

3.3.2 Mathematical Formulation

To describe the propagation of a quantum field near the EEH, we can use an analogy with the one-dimensional stationary Schrödinger equation with an effective potential:

$$\frac{d^2u}{dr_*^2} + [\omega^2 - V_{\text{eff}}(r)]u = 0 \tag{13}$$

Wave function of the photon at the EEH:

$$\psi(r) = Ae^{i\omega r/c} + Be^{-i\omega r/c} \quad \text{for } r < R_{EEH} \quad (14)$$

$$\psi(r) = Ce^{-\kappa(r-R_{EEH})} \quad \text{for } r > R_{EEH} \quad (15)$$

where $\kappa \rightarrow 0$ when $E \rightarrow E_{\min}$.

This leads to a reflection coefficient:

$$R = |B/A|^2 = \left| \frac{k - i\kappa}{k + i\kappa} \right|^2 \quad (16)$$

Probability of tunneling:

$$T = 1 - R = \frac{4k^2\kappa^2}{(k^2 + \kappa^2)^2} \quad (17)$$

Quantum reflection coefficient dependent on energy:

$$R(E) = \frac{|\sinh^2(\pi\sqrt{(V_0 - E)/(\hbar c)}) + \cos^2(\delta)|}{|\sinh^2(\pi\sqrt{(V_0 - E)/(\hbar c)})|} \quad (18)$$

In this case, quantum reflection is essentially tunneling in reverse. The photon is in gravitational absorption.

3.4 Energy Balance Upon Return

3.4.1 Initial Energy vs. Return Energy

Initial state:

- Hadronization: $T \sim 10^{11}$ K (emission from the surface of a quark star)
- $E_{\text{initial}} = 8.6$ MeV (high-energy photons)
- Dense, hot matter
- Homogeneous spectrum of a black body

Journey to EEH:

$$E_{\text{out}} = 8.6 \text{ MeV} \quad \Delta E_{\text{loss}} = \int_0^{R_{EEH}} \frac{\partial \Phi}{\partial r} dr \approx 8.6 \text{ MeV} - E_{\min} \quad (19)$$

At the EEH:

- The photon reaches E_{\min} (quantum minimum).
- It "gets stuck" at an individual horizon.

Return (current detection of CMB photons):

- The universe has expanded, density has decreased.
- Gravitational potential $\Phi(r, t_{\text{now}}) \ll \Phi(r, t_{\text{initial}})$.
- Collective effect of subsequent photons and neutrinos \rightarrow expansive energy ("dark energy").

3.4.2 Energy Cycle

Energy Transformation:

$$E_{\text{initial}} = 8.6 \text{ MeV (hadronization)} \quad (20)$$

$$\downarrow \text{ (path to EEH)} \quad (21)$$

$$E_{\text{min}} \approx \text{quantum minimum} \quad (22)$$

$$\downarrow \text{ (return in expanded universe)} \quad (23)$$

$$E_{\text{CMB}} \approx 2.3 \times 10^{-4} \text{ eV} \quad (24)$$

Net Energy Balance:

$$\Delta E_{\text{total}} \approx 8.6 \text{ MeV} - 2.3 \times 10^{-4} \text{ eV} \approx 8.6 \text{ MeV} \quad (25)$$

Cosmological Consequences:

- CMB: Return photons from the EEH (2.7 K background).
- Dark energy: The collective pressure of photons and neutrinos "stuck" at the EEH ($\sim 70\%$ of the universe).
- Expansive effect: The accumulated energy causes the accelerating expansion of the universe.

Fundamental Principle: The energy "lost" in gravitational redshift during the journey to the EEH is not fully returned upon its return in the expanded universe, creating a net energy balance responsible for the observed cosmological phenomena.

3.4.3 Gravitational Explanation of Redshift

Instead of a photon's energy being lost into "expanding space," the SMU posits an energy exchange mediated by gravitational interaction with the universe's global system. It's not a "loss into nothingness," but a cyclic exchange within a closed system! This effect is manifested in current observations of the universe as "dark energy."

The mechanism of redshift in the SMU is more complex than in the traditional Λ CDM model. Photons and neutrinos from the hadronization and baryonization epochs (90% of the radiated mass/energy of the original quark star) in their outward radial motion gradually transferred energy to the expanding matter and spacetime throughout their journey, before reaching the EEH. Spacetime, and thus the vast majority of outer spacetime, has been built, and continues to be built and maintained, by the energy of photons, neutrinos, and other energetically significant particles moving outwards from the system. At the EEH, due to spacetime curvature and a limiting energy loss, a reversal occurs. Photons and neutrinos follow the gravitationally determined most favorable path back to the center of the universe. Meanwhile, however, matter and energy have still significantly progressed radially outwards. Therefore, the reverse "blue" shift, the return of energy back to the photon from the system upon its return to the center, by no means reaches the parameters of the original redshift. The global dynamics of spacetime, especially large-scale gravitational waves, can cause additional redshift even during the photon's return towards the center. This effect also reduces the return energy.

The energy difference between the outgoing and returning photon energy is precisely what we observe as the CMB relic radiation. These are photons that have completed their journey to the EEH and returned with a characteristic energy signature.

Unlike the traditional interpretation in general relativity, where the change in a photon's frequency (redshift) is understood merely as the difference between the gravitational potentials of the emitting and receiving observers, the SMU considers this change to be a real energy transfer between the photon and the system. The photon transfers part of its energy through gravitational interaction to the surrounding matter, other particles, and leptons, thereby forming spacetime and the global metric. This transferred energy is not lost but remains within the system defined by the EEH. The photon's return energy is quantum-assured, but due to energy exchanges, it is not identical to the original.

$$\frac{\Delta E}{E} = \int \frac{\partial \Phi}{\partial r} dr \quad \text{where } \Phi \text{ is the gravitational potential of the global mass distribution.} \quad (26)$$

3.4.4 Conservation of Energy in a Closed System with EEH

One of the greatest advantages of the SMU is its strict energy conservation. Since the universe is a closed system with a defined boundary (EEH), no energy can escape the system. All energy that a photon or neutrino loses due to redshift is actually mediated by the gravitational field to the universe's system, matter, and energy. Photons and neutrinos contribute to the change in the distribution of matter and energy within the global system and the associated expansion of spacetime. This energy is not lost but merely transformed into another form. Mathematically, we express this as the conservation of the total energy

of the system, where individual components can change, but their sum remains constant.

$$E_{\text{total}} = E_{\text{matter}} + E_{\text{radiation}} + E_{\text{kinetic}} + E_{\text{potential}} = \text{constant} \quad (27)$$

Thus, the SMU enables active spacetime genesis and ensures strict energy conservation in a closed system:

$$E_{\text{total}} = \text{constant, while } E_{\text{photon}} = \text{constant.} \quad (28)$$

All changes in the universe, including its expansion, are a consequence of the transfer or exchange of energy between matter (internal, potential, and kinetic energy) and radiation. The metric is merely a manifestation of these interactions. The degree of expansion of the system corresponds to the current imaginary entropy within the system, i.e., the internal arrangement of the universe suitable for our existence. In this sense, entropy, which must be perceived as relative, can be admitted. If we were to apply entropy in the SMU model, entropy would increase during expansion, and during the compression of matter and energy through black holes and their horizon, where the degree of order increases, the system's entropy would decrease. From the perspective of quantum mechanics or an external observer, entropy lacks meaning because the system is always ordered in some way, and only its form changes. It never reaches an energetic death.

Quantum analysis shows that the EEH is not just a geometrical boundary, but a quantum-mechanically impenetrable region for ordinary quantum states. Here, the photon interacts with the spacetime structure in the form of a quantum superposition and cannot cross the barrier defined by Planck parameters. This mechanism ensures the return of information and energy back into the system without loss, in accordance with the law of conservation of energy and quantum information (it resolves the information paradox).

3.4.5 Global Role of Baryonic Matter

In the context of the SMU model, baryonic matter is crucial for structuring local gravitational fields, for example, in the formation of stars, galaxies, and galaxy clusters. From a global perspective, however, it represents only a small part of the total energy balance of the system. Most of the energy and gravitational potential are determined by photons, neutrinos, and the global geometric effects they induce, especially large-scale gravitational waves. Baryonic matter is strongly localized and, on a cosmological scale, acts as the center of the global metric. The EEH, the metric structure of the universe, and its dynamics are primarily formed by radiation and its interaction with spacetime.

3.4.6 Metric as an Emergent Property

$$g_{\mu\nu} = f(E_{\text{radiation}}, \text{distribution}_{\text{matter}}, \text{time}) \quad (29)$$

4 Quantum Coherence and Information

The conservation of quantum information equals the conservation of system energy.

A photon at the EEH does not lose its quantum identity:

- Spin is conserved.
- Polarization is conserved.
- Quantum numbers are conserved.

This implies for the SMU model that CMB photons are quantum "echoes" of the original photons from hadronization on the surface of a quark star, carrying information about the original state of the star with a modified spectrum.

A photon truly:

- Cannot be destroyed – it maintains quantum existence.
- Has minimum Planck energy at the EEH.
- Must return due to quantum uncertainty and the absence of further space.
- Regains energy back, but not entirely (\rightarrow redshift).

The SMU model introduces an informationally consistent quantum horizon that is not a black hole, but a quantum boundary of space. The model resolves the information paradox differently than Hawking [4]; information (energy) does not leave the system, it has no alternative. The entropy of the system remains unchanged.

$$\Delta S = S_{\text{final}} - S_{\text{initial}} = 0 \tag{30}$$

The concept of a Planck barrier and quantum reflection is hypothetical and not part of standard physics. It is a speculative mechanism requiring further theoretical and experimental verification.

5 Structure of Black Holes

5.1 Quark Stars Instead of Singularities

The SMU model rejects the formation of mathematical singularities as a result of gravitational collapse. Instead, it posits that upon exceeding the Tolman–Oppenheimer–Volkoff limit (TOV limit) [8], a neutron star transforms into a stable quark star [11] without forming a point of infinite density.

Current physics struggles with the concept of singularities, i.e., points of infinite density where known physical laws break down. The SMU offers a more realistic alternative.

During the collapse of a massive star, a mathematical singularity does not form; instead, the neutron star gradually transforms into a quark star. A quark star represents a state of matter with extreme density, where quarks are "unbound" from their confinement within the internal structure of hadrons. This allows them to be compressed much more tightly than entire nucleons. The event horizon, whose effects we see around such an object, is therefore a boundary of information and photon/neutrino energy sharing, beyond which real physical processes with real matter occur.

Neutron Star \rightarrow Quark Star: The Tolman-Oppenheimer-Volkoff limit (TOV limit) indicates the maximum mass of a neutron star. When exceeded, collapse occurs into a new, quark state, not the formation of a mathematical singularity.

$$M_{\text{critical}} \approx 2 - 3M_{\odot} \tag{31}$$

$$\rho_{\text{core}} \sim 10^{15} \text{ kg/m}^3 \rightarrow 10^{18} \text{ kg/m}^3 \tag{32}$$

5.2 Hierarchy of Quarks and Binding Energies

As a quark star is compressed, pressure and internal energy increase. This energy can be absorbed through transformations between different quark states (flavors). The weak interaction allows lighter quarks (up, down) to transition into heavier ones (strange, charm, bottom, and theoretically, top) [5]. Each such transition requires higher binding energy, enabling the system to accumulate energy without the need for further expansion. Each higher quark state demands greater binding energy, thus allowing the system to absorb and accumulate energy in the form of mass potential.

Top quarks have a mass of around 173 GeV, which is almost 200 times more than the energy of a typical proton. In this way, a quark star functions as a natural energy accumulator, allowing for the stable storage of an enormous amount of energy without the need for expansion or structural destruction. This property is crucial for the cyclic compression phase in the SMU model.

Approximate Binding Energies of Quark States:

- $E_{\text{binding}}(\text{top}) \sim 100 - 200 \text{ GeV}$
- $E_{\text{binding}}(\text{charm}) \sim 1 - 2 \text{ GeV}$
- $E_{\text{binding}}(\text{strange}) \sim 0.1 - 0.2 \text{ GeV}$

This hierarchy of quark energy states is not considered random or purposeless within the SMU. On the contrary, the SMU model understands this structure as a physical mechanism for the long-term accumulation of energy in compressed quark matter.

$$E_{\text{quark}} = \sum_{i=1}^n N_i \cdot E_{\text{binding},i} \quad (33)$$

The SMU model replaces the concept of singularities with real existing quark objects. Compact quark stars represent stable states of extreme density that can absorb significant amounts of energy through the transformation of quark states. This opens up the possibility of continued evolution without violating the laws of physics, even when exceeding the TOV limit. Thus, quark matter becomes a key element for energy accumulation within a quark star in the final phase of the universe's cycle.

6 Cyclic Evolution of the Universe

6.1 Compression Phase

Gradual accumulation of matter into a central Mother Black Hole (MBH).

The SMU model assumes a cyclic evolution of the universe, where a phase of expansion alternates with a phase of compression. Currently, we observe the expansion phase, but in the long term, it is expected that prevailing gravitational forces will cause all matter and energy to re-concentrate into supermassive black holes. These black holes will absorb each other until one enormous central black hole, a Mother Black Hole (MBH), forms, containing most of the universe's energy. During this process, energy gradually concentrates and is stored in quark structures within this supermassive black hole. Almost the entire universe will thus gradually concentrate into a relatively small but extremely dense object.

$$M_{\text{MBH}} = \int \rho(t) dV = f(t) \cdot M_{\text{universe}} \quad (34)$$

At this point, the event horizon of the MBH will practically merge with the External Event Horizon (EEH).

6.2 Critical Point and Expansion

Although relatively small, the immense quark star will reach a phase where, due to extreme pressure and temperature conditions and the limits of information transfer governed by relativistic laws, the quark star will lose gravitational cohesion, and expansive effects will prevail. The initial expansion associated with the redistribution of energy will trigger a positive feedback loop, leading to a rapid expansion of the system—similar to an inflationary phase, but without the need for a quantum vacuum. As lower temperatures are reached in the outer sphere of the expanding star, hadronization and phase transitions will occur:

$$\rho_{\text{critical}} \sim \rho_{\text{Planck}} = \frac{c^5}{G^2 \hbar} \sim 5 \times 10^{96} \text{ kg/m}^3$$

The surface of the star will begin to radiate high-energy photons and neutrinos; the accumulated energy in heavy quarks will start to be released.

The SMU model describes the universe as a cyclically evolving system in which energy accumulated in the quark phase, upon reaching critical conditions, leads to energetically moderated expansion. This transition is not a sudden "Big Bang" from nothing, but a continuous progression of evolution, governed by physically consistent processes of energy accumulation and release. The EEH boundary shifts with this evolution, defining a closed yet dynamically changing space.

6.3 Role of Baryonic Matter in the Cycle

Although most of the quark star's energy is radiated away as photons and neutrinos during expansion, the SMU model assumes that a portion of the quark matter always persists as baryonic matter. Certain quark states are quantum mechanically stable and cannot be fully transformed into radiated energy. As the system cools and energy decreases, a phase occurs in which matter "survives" as a baryonic structure. It is precisely this surviving matter that is essential for the formation of stars, galaxies, and ultimately, black holes. Without it, no gravitational accumulation could occur in later stages of evolution, and thus no return phase of the cycle. The universe would then remain dispersed as homogeneous radiation, with no possibility of further collapse. The universe would thus remain dispersed in the form of homogeneous radiation, without the possibility of concentration into the MBH.

This means that baryonic matter, despite forming only a fraction of the total energy, plays a key role as the carrier of the cycle's returnability. It ensures that the universe does not end in a state of pure entropy (Big Freeze), but has the potential to reorganize and accumulate again.

7 Photon and Neutrino Expansion

7.1 Active Genesis of Spacetime

The SMU hypothesis proposes that photons and neutrinos actively participate in the genesis of spacetime. They are not merely incidental byproducts of energy exchanges; instead, they determine its structure through their energy content and distribution.

$$G_{\mu\nu} = \frac{c^4}{8\pi G} (T_{\mu\nu}^{(\text{matter})} + T_{\mu\nu}^{(\text{radiation})}) \quad (35)$$

7.2 Collective Effect of Radiation

Individual photon: minimal curvature

$$\delta g_{\mu\nu} \sim \frac{G \cdot h\nu}{c^4} \quad (36)$$

Collective effect of N photons:

$$\Delta g_{\mu\nu} \sim \frac{G \cdot N \cdot \langle h\nu \rangle}{c^4} \quad (37)$$

The SMU assumes that 90 to 95% of the original energy of the quark star was released in the form of radiation—photons and neutrinos. This released energy is the driving force behind the universe's expansion. It forms spacetime, and the EEH is spherically pushed outwards.

8 Thermodynamic Expansion

The thermodynamic expansion of the quark-gluon plasma (QGP) took place in parallel with the photon and neutrino expansion. This phase represents a crucial moment when matter, as a force-bound quark system, begins to expand thermodynamically due to internal pressure and, through gravity, interacts with radiation, which co-creates and modulates the global geometry of space-time. Due to these effects, the quark star expanded to the dimensions of the future atomic universe. The expansion of the QGP led to a decrease in temperature and the start of the global process of hadronization and nucleosynthesis. The matter acquired significant centrifugal kinetic energy, which was used in the formation of the atomic universe. At the end of the existence of the quark star, matter condensed into the structures that we now observe in the universe. The entire process of the expansion of the quark star is about the dissipation of the QGP energy into the space bounded by the EEH of the spherical universe. The geometry and distribution of matter and energy changed.

The thermodynamic expansion of the quark-gluon plasma represents a key moment in the evolution of the SMU universe. It is a phase where strong, thermodynamic, and gravitational processes intertwine, creating the conditions for the formation of the future atomic universe. The interaction between radiation and quark matter led to the controlled expansion of the system and the transfer of energy into structured space within a dynamic, metrically defined whole.

With regard to the geometric structure of the spherical universe (see Chapter 2) and considering the dynamics of the expanding quark star in the final phase of its existence, influenced by gravitational waves, we can observe the universe from our position as approximately "flat." Let us realize that the universe we observe is only a small fraction of

the global system of the universe according to the SMU, where the global character of the system is minimally expressed.

9 Explanation of Dark Energy

In the Λ CDM model, the accelerated expansion of the universe is explained by the presence of dark energy—a hypothetical form of energy of space with a repulsive gravitational effect. However, its physical nature remains unknown.

The SMU model interprets the accelerated expansion not as the effect of an unknown substance, but as a dynamic consequence of the gravitational influence of relic radiation, photons, and neutrinos, which has been and is accompanied by the expansion of spacetime. This is an energy exchange mediated by global gravity.

9.1 Delayed Gravitational Effect

Information about global gravity propagates at the speed of light. At the EEH boundary:

$$t_{\text{delay}} = \frac{R_{\text{EEH}}}{c} \quad (38)$$

Actual gravitational influence vs. observed:

$$g_{\text{actual}} = \frac{GM}{r^2} \quad (39)$$

$$g_{\text{observed}} = \frac{GM(t - t_{\text{delay}})}{r^2} \quad (40)$$

9.2 Negative Gravitational Pressure

The difference creates an effective "negative pressure":

$$p_{\text{eff}} = -\rho_{\text{eff}}c^2 = -(\rho_{\text{actual}} - \rho_{\text{observed}})c^2 \quad (41)$$

9.3 Summary: Multilayered Structure of Energy Flows

9.3.1 Original Wave of Radiation (Hadronization - 95% of mass)

- Massive outward energy flow
- Creates spacetime curvature
- Establishes global gravitational potential

9.3.2 Nucleosynthesis

- Another wave of radiation with a different energy spectrum
- Interaction with existing curvature
- Modifies the trajectories of all subsequent photons

9.3.3 Current Radiation

- Superposition with previous layers
- Interacts with the changing global metric
- Delayed gravitational effect

9.3.4 Key Problem: Gravity information propagates at speed c

$$\Phi_{\text{actual}}(r, t) = \Phi_{\text{observed}}(r, t) \quad (42)$$

$$\Phi_{\text{observed}}(r, t) = \Phi_{\text{actual}}(r, t - r/c) \quad (43)$$

A photon "sees" a gravitational field that no longer corresponds to the actual distribution of matter and energy!

9.3.5 Complex Photon Trajectories

During its journey, a photon:

- Gains energy (blue shift) when moving into a gravitational "well"
- Loses energy (red shift) when leaving a gravitational field or decelerating expansion
- Changes direction due to gradients in the changing metric

Mathematically:

$$\frac{dE}{ds} = -\nabla\Phi_{\text{effective}} \cdot \frac{dx}{ds} \quad (44)$$

Where $\Phi_{\text{effective}}$ includes:

- Gravitational influences of local masses
- Gravitational influences of flowing energy (counter-propagating photons and neutrinos)
- Global gravity manifesting with a delay
- Global gravitational waves

A practical consequence then is that a photon from the original quark star can have a curved trajectory through several "gravitational domains." It can change the sign of its shift several times (red \rightarrow blue \rightarrow red). Its final redshift is the integral of its entire interaction history. Therefore, in the SMU, redshift is not a simple indicator of distance, but a complex signature of gravitational history.

A photon is not just "a particle flying through space," but rather a quantum object integrated into the global structure of spacetime:

$$|\text{photon}\rangle = \int \psi(\text{trajectory, causal structure, energy})|\text{path}\rangle d(\text{path}) \quad (45)$$

From emission to absorption, it exists as a superposition of all possible trajectories, with the "global information system" (gravitational field + quantum mechanics) determining the most favorable path.

In accordance with the principle of least action in curved spacetime, the photon "chooses" its trajectory according to:

$$\delta S = \delta \int L ds = 0 \quad (46)$$

But SMU assumes that the Lagrangian is dynamic—it changes with the evolution of the global gravitational field. The photon thus "knows" about:

- Future changes in the metric
- Delayed gravitational effects
- The total energy balance of the system

10 Cosmic Microwave Background (CMB)

10.1 Origin in Hadronization, Baryonization

In the classical interpretation (Λ CDM), the cosmic microwave background (CMB) is a remnant of the last scattering, i.e., the moment when photons decoupled from matter in the early universe. The SMU assumes that the CMB represents the return of photons from the hadronization era of a quark star:

$$T_{\text{CMB}} = T_{\text{hadronization}} \times \left(\frac{a_{\text{then}}}{a_{\text{now}}} \right) \quad (47)$$

10.2 Statistical Distribution of Photons and Neutrinos According to Λ CDM

According to current measurements, the mean density of relic photons is approximately:

$$n_\gamma \approx 410 \text{ cm}^{-3} \quad (48)$$

$$E_{\text{photon}} \approx 6 \times 10^{-4} \text{ eV} \quad (49)$$

And for relic neutrinos:

$$n_\nu \approx 340 \text{ cm}^{-3} \quad (50)$$

The photon background is measured on Earth. However, the density of relic neutrinos is not directly measured and is derived theoretically according to Λ CDM.

At a quark core temperature of approximately 10^{11} K, during the deconfinement \rightarrow hadronization \rightarrow nucleosynthesis transition, 90 to 95% of the original mass of the quark star was radiated in the form of photons and neutrinos. It is estimated that 65% of this energy was carried by photons and 35% by neutrinos. However, the numerical ratio corresponds to 75% neutrinos and 25% photons. Photons at this temperature had energies up to 8.6 MeV, but today in the CMB they carry only $234.7 \mu\text{eV}$. In contrast, the rest mass energy of a neutrino is 0.1 eV, which is more than 400 times more than today's CMB photons.

Unlike photons, neutrinos have a rest mass and can travel sub-light. Due to their inertia and weak interaction with baryonic matter, it is probable that global gravity concentrated most neutrinos into the baryonic central region of the universe. While photons lost a significant part of their energy due to metric dissipation, neutrinos became the dominant mass-energy of the total relic radiation. As a result, it can be expected that the gravitational field in the central region of the universe is significantly influenced by neutrino density, while the direct influence of photons is negligible.

10.3 Synchronous Arrival with Gravitational Waves

The CMB arrives synchronously with a "negative gravitational wave":

$$h_{\mu\nu} \propto \frac{\partial}{\partial t^2} \frac{\partial^2}{\partial^2} \left(\frac{c^2 r}{GM} \right) \quad (51)$$

The energy radiated by the original quark star triggered the formation of spacetime and an enormous gravitational wave. The photons and neutrinos that return to us in the form of the CMB, synchronously with the gravitational wave, carry information about this wave, about the negative energy that continues to expand only the inner sphere of the universe. The source of the sought-after "dark energy" is precisely these CMB photons

and neutrinos.

10.4 Recalculation of Temperature Scales

Original processes in the quark star:

- Hadronization: $10^9 - 10^{12}$ K
- Baryonization: $10^9 - 10^{11}$ K
- Range of variations: $\Delta T \sim 10^8 - 10^{11}$ K

CMB observations:

- Average temperature: 2.7 K
- Fluctuations: $\Delta T \sim 10^{-5}$ K (microkelvin!)

Through transformation, we arrive at a completely different interpretation of the CMB. Ratio of original \rightarrow current temperature:

$$\frac{T_{\text{original}}}{T_{\text{CMB}}} \sim \frac{10^{12}}{3} \sim 3 \times 10^{11} \quad (52)$$

But relative fluctuations:

$$\frac{\Delta T_{\text{original}}}{T_{\text{original}}} \sim 0.1 - 10\% \text{ (gigantic processes!)} \quad (53)$$

$$\frac{\Delta T_{\text{CMB}}}{T_{\text{CMB}}} \sim 10^{-5} \text{ (microscopic variations)} \quad (54)$$

These "fine" microkelvin variations in the CMB are actually imprints of gigantic energetic processes—phase transitions between different quark states!

$$\Delta \varepsilon_{\text{quarks}} \sim \text{GeV energy} \rightarrow \Delta T_{\text{CMB}} \sim \mu\text{K} \quad (55)$$

Thus, the CMB map is not a map of "primordial fluctuations," but a current snapshot of energetic processes on the central quark star.

This explains why CMB anisotropies are so precisely structured and correlated with large-scale structure!

The CMB does not represent the past, but is a projection of the current quantum-information interaction between us and a distant region of the quark/hadronization phase of the universe. Since information about this region comes to us with characteristics given by causality in the trajectory, the key is not the time of origin itself, but the state relationship between us and this process. The temperature of this phase (10^9 – 10^{12} K) gives a new insight into the temperature anisotropy of the CMB. The CMB is not "fossil"

radiation from the past. It is a current reflection from the surface of a quark star, a QGP object. We observe a "living" process, but an extremely slowed down one. According to Λ CDM, $z = 1100$. At the original minimum temperature of 10^9 K on a quark star, $z \approx 3.7 \times 10^8$. Due to time dilation, we see only approximately 0.08 seconds of the process on a quark star in one year of our time.

We have already sufficiently mapped the anisotropy, dipole, quadrupole and other asymmetries in the CMB. It can be used as a map of the relative geometry of the universe using mathematical models. For example, the detected asymmetry between the hemispheres can indicate our position in the geometry of the universe and our velocity. Based on the Doppler effect, we can calculate our velocity relative to the CMB, but part of this redshift can also reflect how far and in what direction we are outside the geometric center of the spherical universe enclosed within the EEH. From these data, the direction and structure of this sphere can be deduced (the center is probably located approximately in the direction of the Crater constellation). The identified quadrupoles in the CMB could then be explained by the effects of a global gravitational wave (or more waves), which deform the paths of photons differently depending on the direction. Photons flying in the direction of the axis would manifest themselves in a dipole, while photons in perpendicular directions in quadrupoles. The strength of this effect should decrease with higher multipoles, which in turn could indicate the presence of more complex gravitational structures.

In light of this, we can expect well-developed galaxies with high mass and order, and massive black holes at the centers of galaxies, which, according to Λ CDM, should not have had time to grow even with extreme accretion. This suggests that the CMB is not causally directly related to the formation of baryonic matter in the universe.

11 Information Paradox and Quantum Gravity

A deeper connection is likely emerging between:

- Quantum non-locality (photon as a superposition of trajectories)
- Gravitational geometry (curved spacetime)
- Informational structure (global coherence of the system)

Perhaps this is an illustration of what quantum gravity looks like in practice, not as quantized gravitons [2], but as quantum coherence of the entire system. Redshift is thus truly not just a Doppler effect, but an "informational signature" of quantum-gravitational interaction within a globally coherent system. Paradoxically, a situation may arise where the emission of a photon occurred in the same place (geodesic of an external observer) as the interaction at the point of measurement, with the same local velocity and its

vector of source and target. We can see a parallel here with quantum entanglement on cosmological scales. In the CMB, for example, we currently see the state of the quark star, but the time cannot be determined, which does not matter at all; we can perceive it as current reality. The CMB is not an “imprint from the past,” but the current state of the system manifesting through quantum coherence. The global information system “calculated” the most advantageous trajectory for this photon, and it is fascinating that this photon is timelessly entangled from emission to interaction. A photon is not just “a particle flying through space,” but rather a quantum object integrated into the global structure of spacetime.

$$|\text{photon}\rangle = \int \psi(\text{trajectory, causal structure, energy}) |\text{path}\rangle d(\text{path}) \quad (56)$$

From emission to absorption, it exists as a superposition of all possible trajectories, with the “global information system” (gravitational field + quantum mechanics) determining the most advantageous path. SMU assumes that the Lagrangian is dynamic—it changes with the evolution of the global gravitational field.

11.1 Information Paradox

How can a photon “know” about future states of the system? Perhaps because, similarly to the block universe theory [?], time is not a fundamental dimension but an emergent phenomenon. The entire “history” of the photon exists simultaneously as a geometrical object in 4D spacetime.

If we accept such an approach, much changes in cosmology:

- Time ceases to be a universal background and becomes a local parameter of atomic and gravitational processes.
- Distance is not an absolute geometrical quantity, but an informational measure of causal separation between events.
- The history of the universe does not arise according to an external linear time, but emerges from the causal structure and internal dynamics of the system. What we call the “timeline” is the result of a structured sequence of interactions.
- Observation is not passive reception of old light, but active quantum interaction.
- The universe does not evolve in time, but generates time through causal sequences.

In a quantum universe, time as a global dimension is not necessary. The universe functions through causal succession, not in absolute time. The local concept of time is meaningful only where a sequence of changes can be distinguished within a closed system

(e.g., the Solar System). The surrounding distant universe functions through causal succession. The universe evolves in the topology of events, not in time. From the perspective of quantum physics and nonlinear systems, causal succession is the fundamental organizational principle, not a destructive scenario. The idea of the heat death of the universe is merely an extrapolation of local entropy, not a law for the entire quantum topological whole. That would be systemic self-destruction, and we would not exist currently. Globally, however, the universe is “outside time” and only a structure of events exists, not a running clock. Quantum reality seeks the most advantageous trajectory where an energetically and informationally favorable change of state occurs, and time appears here only as an auxiliary quantity within a subsystem.

In the quantum description of the universe, if we speak of a closed system, quantum entropy remains constant, specifically zero. Thus, the entropy of the whole is immutable and meaningless. The second law of thermodynamics applies only locally, in non-isolated systems, and the reason for this is that we perceive the passage of time.

This does not mean that we can do without time in cosmology. In a local description of events, we simply need it because it emerges from the very causal relationships that structure reality. We use time as a local language of causality to quantify the speed of light, frequencies, gravitational waves, particle decay times, synchronization between two events, and so on. Time is relative, but not superfluous. Time is a meaningful tool where it is possible to locally define events in relation to a causal sequence that can be measured through frequency, speed, or trajectory. This area is limited to a sufficiently clear local space with a consistent metric.

12 Relic Photons and Neutrinos as Hidden Components of Mass and Energy – “Dark Matter” and “Dark Energy”

The SMU posits that the vast majority of the original quark star’s energy and mass was released as radiation – specifically photons and neutrinos – during the hadronization and baryonization phases. The model estimates that up to 95% of the initial mass was radiated in the form of these particles. Since the SMU is interpreted as a closed energy system, no form of energy can leave the system, including photons and neutrinos. Their very presence thus explains the mystery of “dark matter” and “dark energy.” In the hadronization phase, they were, and still are, primarily the “dark energy” that shaped and continues to shape spacetime. Now, some of them have become relic photons and neutrinos that have already transferred most of their energy to the system. With the loss of energy, their trajectories became confined closer to the region of baryonic matter. While photons maintain the speed of light, neutrinos with rest mass can also be partially gravitationally slowed and

bound. In both cases, the collective effect of these particles manifests gravitationally as dark matter. Neutrinos with rest mass could additionally be gravitationally bound and slowed, which would explain their concentration around galaxies.

Photons and neutrinos were not destroyed or annihilated; they merely shifted beyond the detection threshold. As for photons, it is probable that part of the so-called cosmic radio noise is a manifestation of this extremely long-wavelength component of relic radiation. We cannot detect neutrinos due to their extremely weak interaction with baryonic matter. Even at this low energy level, these particles remain gravitationally effective and contribute to the formation of structures in the universe.

From the perspective of general relativity, every particle with energy, no matter how extremely low, has a gravitating character. This means that even very weak relic fields (photonic and neutrinoic) contribute to the curvature of spacetime. Although these particles do not themselves form stars, galaxies, or plasma, they create a collective gravitational potential.

12.1 Dark Matter

A peculiar role is played by the fact that photons and neutrinos are energy carriers and travel very long distances. Their motion is causally diverse, and they can travel billions of years (measured by our local metric). They remain part of the global gravitational field, which they simultaneously and permanently influence. Their motion and presence in space fundamentally affect the formation of spacetime. This influence manifests relativistically, with a time delay. Therefore, they can change the geometry of the universe gradually and causally very complexly, in continuity with older interactions.

This means that their action is not merely passive. They are part of a causal information network, entangled with the current metric, and potentially creating inhomogeneities that manifest in the expansion of the observed universe, galaxy rotations, and the curvature of light paths.

In connection with these considerations about relic matter and energy, it is appropriate to address the common objection that dark matter cannot be composed of ordinary (baryonic) matter. This argument is championed, for example, by Prof. RNDr. Pavel Kroupa, Ph.D., and is based on dynamic observations of galaxies [6]. In a baryonic model, dark matter would have to form extensive clouds of matter in galaxies, whose density would be sufficient to influence the movement of other structures, such as stellar populations or smaller galaxies in the vicinity. Such clouds would have to interact through gravitational influence, but also through weak collisions or gas pressure (especially during high-energy galaxy motion). This would lead to so-called dynamical friction, i.e., the deceleration of bodies due to inertial interaction with the medium. If dark matter were baryonic, we would have to observe such a phenomenon, which, however, does not correspond to

reality. Galactic rotations and the movements of satellite galaxies show minimal resistive effects.

Photons and neutrinos are not baryonic in nature and do not form clouds. Based on this, the SMU proposes that the main candidates for dark matter are relic photons and especially neutrinos, which do not form clouds, and neutrinos interact almost no mechanically. Their concentration is not the result of collisions, but of gravitational steering; they behave as streams or highways of photons and neutrinos in a dynamic gravitational environment. Therefore, in the environment of galaxies, there is no friction, they do not deform the trajectories of baryonic matter by resistive effect, but nevertheless maintain dynamic equilibrium through their mass and energy in space and, together with baryonic matter, form a kind of gravitational web.

12.2 Dark Energy

The SMU posits that dark energy is energy that was emitted but is no longer directly detectable today because it was, and still is, transferred to the system, and the response, the gravitational influence, is that dark energy.

Photons and neutrinos that were radiated during the hadronization of the quark star represent 90 to 95% of its original mass. The energy balance of the photon was performed, see section 3.4.1; for neutrinos, the balance will likely be in relation, but CNB neutrinos have not yet been directly detected. The return of photons in the form of CMB is a signal that this negative gravitational influence, this energy, is currently at play.

Dark energy can be interpreted as the energy difference between the originally emitted energy and the energy we can perceive (or detect) today:

$$E_{\text{dark}} = \sum_i (E_{\text{emit}}(i) - E_{\text{today}}(i)) \quad (57)$$

Where index i runs over all quantum energy carriers – i.e., especially photons and neutrinos.

For photons:

$$E_{\text{dark}}(\gamma) = \int_0^{N_\gamma} (h\nu_{\text{emit}} - h\nu_{\text{CMB}}) dN \quad (58)$$

For neutrinos:

$$E_{\text{dark}}(\nu) = \int_0^{N_\nu} \left(\sqrt{p_{\text{emit}}^2 c^2 + m_\nu^2 c^4} - \sqrt{p_{\text{today}}^2 c^2 + m_\nu^2 c^4} \right) dN \quad (59)$$

This energy difference is not a loss, but rather energy transferred through gravity to the central part of the spherical system. Here resides all baryonic matter, active photons and neutrinos from baryonic matter, relic photons, and relic neutrinos. Dark energy is not a mysterious force of expansion, but a global accounting difference between the radiated

and detectable energy of all quantum carriers.

12.3 Summary

Neutrinos and relic photons represent a natural, physically known basis for dark matter. Their current unobservable behavior is not a sign of absence, but a consequence of low energy, extremely weak interaction, and causal spatial distribution. CMB photons and accompanying neutrinos are the essence of dark energy supporting the expansion of the universe's baryonic matter. The SMU, thanks to its strict conservation of energy and quantum identity, allows for the precise inclusion of this hidden matter and energy into the gravitational balance of the universe system.

13 Comparison with the Λ CDM Model

Property	Λ CDM	SMU
Geometry	Flat, potentially infinite	Flat in a spherical formation, finite
Dark Energy	Cosmological constant Λ	Active photons, neutrinos (CMB)
Redshift	Expansion of space	Gravitational interaction
Energy Conservation	Problematic	Strictly conserved
Spacetime	Pregiven	Formed by energy
Dark Matter	Unknown matter	Relic neutrinos and photons
What is CMB	Global recombination shell	Surface of quark star
Observation time per year	8 hours	0.08 seconds
Dipole	Our speed	Our speed and eccentricity
Quadropoles	Does not explain	The influence of gravitational waves

Table 1: Comparison between Λ CDM and SMU models

14 Discussion

Although the presented Spherical Model of the Universe (SMU) is formulated as energetically conservative, closed, and metrically self-contained, the existence of variants that would preserve its basic principles while expanding the interpretative framework cannot be ruled out.

For example, it cannot be excluded that our universe is part of a larger gravitational system – for instance, the content of a black hole within an “outer universe.” Similarly, one can speculate that extremely massive black holes within our own universe may contain embedded geometries that can be perceived as local or independent universes.

Such possibilities cannot be confirmed or refuted by available means, but the SMU model is fundamentally compatible with them. Its main goal is not to describe the ultimate truth about the universe but to offer a consistent, closed, and quantumgravitationally

oriented framework for understanding the universe without the need for external entities, hidden energies, or violations of conservation laws.

A system of nested universes, where each inner space is contained within the gravitational volume of a higher-level black hole, could naturally concentrate matter and energy from outer structures towards the innermost point, the last closed system. In this innermost system, accumulation, critical collapse, and re-release of energy could occur – thus triggering a new phase of the cycle. This architecture allows matter and energy to never be lost, but merely transformed and shifted between levels.

We observe the impacts of extremely energetic particles – for example, cosmic rays with energies exceeding 10^{20} eV, whose origin cannot be unambiguously explained within known astrophysical processes [?]. Within the broader perspective of the SMU, these might be traces of inter-universal particle accretion that have undergone a gravitational transition between systems (for example, through black hole accretion) and entered our spacetime as energetic relics of an outer layer of reality. The particles' composition corresponds to star accretion. The probability of Earth being hit from star accretion into our universe (our BH) corresponds to the scale of star – our universe.

Such a possibility does not disrupt the closed nature of the SMU at a given level but suggests that a closed system can be part of a larger structure that itself is subject to gravitational and quantum laws. In the SMU model, space and time are not born from nothing but are the result of the presence of matter, energy, and interactions. During particle accretion into a black hole, its speed cannot grow beyond the limit c , but its energy increases the internal curvature and thereby “pushes” metric space inwards into the black hole. This mechanism mirrors the expansion of the quark star. While spacetime formed outwards there, here it forms inwards. The internal space of a black hole is thus not a pre-given volume, but a dynamic region generated by the matter and energy entering it.

15 Concluding Summary

The essence of the Spherical Model of the Universe (SMU) lies in its spherical nature, not merely as a geometric assumption, but as a principle of organizing matter, energy, causality, and metric. It fully preserves the law of conservation of mass and energy. Every physical process – be it expansion, accretion, emission, or gravitational collapse – takes place within a metric space whose energy balance is immutable. In this conception, energy and matter cannot be relative in the sense of existence. They may appear differently to different observers in an object-to-object relationship, but it is always a relativity between two absolute states, not a relativity of existence itself. Energy is thus not just a parameter in equations, but the conservative core of the universe's structure, surviving every phase of the cycle and acting as an active agent in the formation of spacetime.

The sphere cannot be understood merely as a shape; within the SMU, it represents closure, energetic completeness, symmetry within the External Event Horizon (EEH), and simultaneously a feedback loop between particles, space, and time. All dynamic processes, from the expansion of the quark star through relic fluctuations to gravitational collapse, occur within a sphere that defines not only space but also the range of permissible physical events.

The SMU thus offers a vision of a universe that is self-sufficient, closed, cyclic, and geometrically anchored – spherical not only in space but also in the sense of physical laws.

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