The Principle of Universal Replication

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Abstract

This work presents the Principle of Universal Replication (PUR), an ontological framework according to which every stable form of coherence—from physical vacuum to matter and life—tends to preserve and reproduce itself over time. The PUR does not introduce new physical forces, but instead names the fundamental property that enables the persistence of ordered configurations in the cosmos. Under this perspective, phenomena such as vacuum expansion, matter stability, and the continuity of the physical forces can be interpreted as manifestations of the same primordial impulse of being. The article explores the cosmological implications of the PUR, its compatibility with the ΛCDM model, and the reason why it excludes a final state of universal heat death.

1 Introduction

From the very first instant of the cosmos, reality has displayed a decisive property: the capacity to preserve and reproduce its configurations. Structures not only arise, but persist, repeat themselves, amplify, and stabilize across immense scales. From atoms to galaxies, and from elementary particles to life, everything seems to respond to the same fundamental impulse: to maintain its form, prolong its coherence, and replicate its existence.

We call this property the *Principle of Universal Replication* (PUR). It does not add new physical forces, but instead names the ontological characteristic that makes it possible for stable configurations to endure over time. Thanks to this principle, primordial energy did not dissipate without leaving a trace: it gave rise to vacuum, to matter, and, eventually, to conscious life.

The PUR is linked to the primordial force, the unique interaction that governed energy before the differentiation of the four known forces. That initial force expressed the same impulse that later manifests as the PUR: the tendency of being to persist and to organize itself. Thus, the origin of the cosmos and the conservation of coherence are not separate events, but manifestations of the same fundamental reality.

2 General Statement

In every physical system, internal coherence tends to sustain and replicate itself in proportion to its stability. Structures that achieve equilibrium—energetic, spatial, or material—reproduce their configuration, generating continuity and order in the universe.

We define *Structural Coherence* C as the amount of order a system can maintain or reproduce over time. It is high for organized structures (a galaxy, a DNA molecule) and

low for random states. C measures a system's resistance to entropy and its capacity for self-replication.

Symbolically, the principle is expressed as

$$\frac{dC}{dt} \propto C, \tag{1}$$

whose formal solution is

$$C(t) = C_0\, e^{kt}, \tag{2}$$

where C_0 is the initial coherence value and k is a coefficient that measures how efficiently the system neutralizes entropy.

In vacuum, k reflects the rate of spatial expansion. In matter, it reflects stability against disorganizing forces. In life, it reflects the balance between information replication and entropic degradation.

The preservation of being does not imply immobility, but active continuity: a system maintains its identity by renewing its coherence over time. Permanence is fulfilled through change.

3 The Need for a Generating Principle of Order

The universe could not have developed without a principle that ensures the preservation of order against entropy. Expansion, matter formation, and the stability of physical laws all respond to the same tendency: the replication of coherence.

The PUR acts as a foundational generator of stability: it drives the preservation and multiplication of coherent states. It is not an additional force, but a universal property implicit in natural laws. Its value is unifying: it allows us to understand as facets of the same impulse processes as diverse as vacuum expansion, gravitation, and biological replication.

This principle is compatible with the second law of thermodynamics: the emergence of organized structures in open systems (galaxies, living organisms, self-organized configurations) does not contradict the global increase of entropy, but complements it within the overall flow of the cosmos.

4 Energy, Vacuum, and Matter: Modes of Being and the Primordial Force

In cosmology, it is often said that in the first instants of the universe the temperature was "maximal." This expression can be misleading if interpreted using ordinary notions of heat, particles, or matter, because in the initial instant no separate particles existed, matter did not yet exist, and spacetime itself had not fully emerged. Therefore, there was no physical "thing" that could be hot in the usual sense.

In this context, the word temperature does not describe material heat, but the extreme degree of excitation and energy density of the primordial field that constituted the totality of being in its most concentrated state. The Planck temperature—the physical limit above which our current laws lose meaning—thus corresponds to the maximum energy density that such a state of being can sustain before beginning its expansion and differentiation.

From the perspective of the Principle of Universal Replication, this initial situation represents the state of absolute coherence of being, prior to any differentiated manifestation in the form of vacuum or matter. "Maximum temperature" does not refer to the presence of hot matter, but to a state in which primordial energy is fully unified, without internal structure and without alternative modes of existence. Only when expansion begins—the first replication of being in the form of physical vacuum—does this extreme concentration relax, allowing the emergence of differentiated modes of coherence: first vacuum, then matter.

When vacuum begins to arise as the first replication of being, the energy density ceases to be concentrated in a single ontological point and begins to distribute itself in the form of extension. This process is precisely what physics describes as cooling: primordial energy ceases to be compressed into an almost zero volume and expands into a growing space.

The decrease in temperature after the initial instant is not material cooling, but the direct consequence of vacuum expansion. As the extent of space increases, energy becomes diluted and its level of excitation decreases. This "cooling" is therefore the thermal reflection of vacuum replication.

Each increment in the extension of vacuum represents a step in the relaxation of the initial energy density, and therefore a corresponding decrease in temperature. Thus, the emergence of vacuum is not only the first manifestation of the Principle of Universal Replication, but also the physical mechanism that enables the rapid descent from the Planck temperature to values that allow the stabilization of later modes of existence, including matter.

In this sense, the cooling of the universe is the thermal imprint of the deeper ontological process: the transition from concentrated being to the multiplication of its coherence in complementary modes.

Once the role of the initial temperature and its descent with the emergence of vacuum is understood, we can return to the fundamental dynamic between energy, vacuum, and matter.

Vacuum is not nothingness: it is dilated energy, an active medium that can expand, sustain fluctuations, and reproduce itself. From it matter arises, where energy condenses into durable configurations. Thus, energy, vacuum, and matter are not successive phases, but coexisting modes of being in replication.

We can express this relationship as

$$\text{Energy} \leftrightarrow \text{Vacuum} \leftrightarrow \text{Matter}. \tag{3}$$

Energy: being in act.
Vacuum: dilated being.
Matter: stabilized being.

Vacuum expansion can be conceptualized through the relation

$$\frac{dR}{dt} = H\,R(t), \tag{4}$$

with solution

$$R(t) = R_0\,e^{Ht}, \tag{5}$$

where $R(t)$ is the radius of an ideal sphere of physical vacuum after a time t, R_0 is its initial radius at a reference instant, and H is a positive constant characterizing the rate of expansion of that ideal sphere.

Gravity, on the other hand, concentrates energy into coherent configurations. Expansion and condensation are two directions of the same principle of continuity, expressed initially by the primordial force and later by the PUR.

5 From Physical Order to Vital Order

Life is not an exception to physical laws, but their natural continuation. Biological replication—DNA duplication, cell division, genetic inheritance—is a local manifestation of the same principle that has operated since the origin: the tendency of being to persist by replicating stable configurations.

In living organisms, energy organizes patterns that reproduce themselves and learn to maintain their structure. Life extends cosmic coherence by integrating information, structure, and metabolism.

$$\text{Energy} \leftrightarrow \text{Vacuum} \leftrightarrow \text{Matter} \rightarrow \text{Life}. \tag{6}$$

6 The PUR as the Ontological Foundation of the Physical Forces

The physical forces we know—gravity, electromagnetism, and the strong and weak nuclear interactions—describe the ways in which energy and matter maintain coherence at different scales. However, these forces do not, by themselves, explain why stability, continuity, or order exist at all, nor why the laws that govern them remain constant over time.

The Principle of Universal Replication (PUR) offers a deeper answer. It does not present itself as an additional force, nor does it compete with the known interactions. Instead, it acts as the ontological principle that makes it possible for the physical forces to exist, to remain stable, and to produce coherence. The PUR does not operate as a dynamic field with its own equations, but as the universal property of being that drives the preservation of coherent configurations and the replication of states that maintain stability.

In this sense, the physical forces can be understood as instrumental manifestations of the PUR, specific expressions of the fundamental impulse of being to prolong itself:

- Gravity concentrates energy and holds extended structures together.
- The strong force preserves the coherence of atomic nuclei.
- Electromagnetism stabilizes atoms, molecules, and repeatable chemical forms.
- The weak force enables transformations that maintain the global continuity of energy and matter.
- The expansion of vacuum, understood as the gravitational effect of a positive energy density of the vacuum itself, represents the prolongation of being in its mode of dilation.

Each of these forces acts as a mechanism through which reality sustains its coherence within a given domain. The PUR does not replace their functioning, but explains their stability and persistence, offering an ontological foundation that precedes them.

Thus, the PUR stands above the physical forces in an ontological sense—not as a force, but as the condition that makes their existence and efficacy possible. It constitutes the primordial impulse of the cosmos to preserve itself, replicate itself, and prolong its coherence at all levels: from fundamental fields to conscious life.

In this sense, the PUR not only grounds the stability of the current physical forces, but also provides a framework for understanding their origin. Before gravity, electromagnetism, or the nuclear interactions existed, the cosmos was in a unified state with no differentiation between forces. The emergence of vacuum—the first replication of being—allowed this primordial state to unfold and the unified energy to differentiate progressively into the interactions we know today. Thus, the PUR does not create the forces as separate entities, but gives rise to the process of expansion and differentiation that makes them possible, acting as the ontological background that drives the transition from primordial unity to the ordered multiplicity of the physical forces.

7 Why the Principle of Universal Replication Excludes the Heat Death of the Universe

As noted in the previous sections, the PUR acts as a generative and conserving foundation of coherence at all physical levels, from vacuum expansion to the stability of matter and living structures. This perspective now allows us to reconsider one of the most widespread cosmological scenarios: the so-called heat death of the universe.

Within the standard ΛCDM framework, and under the assumption that dark energy has a constant and immutable value, it is concluded that accelerated expansion will lead the cosmos to a final state of maximum entropy: a cold, diluted universe devoid of structure. Stars, galaxies, and even stable matter would eventually dissolve into an almost inert regime. This picture implies the complete disappearance of the universe's capacity to generate order.

The PUR is incompatible with such a scenario.

The principle states that the internal coherence of a physical system tends to preserve and replicate itself when it reaches stability. This property is neither local nor contingent: it is the ontological background that made it possible for the universe to evolve from its primordial state into its present configurations. If reality were capable of completely losing its capacity for replication, coherence would have vanished in the first instants of the cosmos, preventing the stabilization of any physical structure, of the fundamental forces, and of the laws themselves.

Heat death, by contrast, requires that coherence C tend to zero, and that the global dynamics of the universe drive $dC/dt < 0$ until all forms of order are extinguished. But such an evolution is forbidden by the PUR. Coherence is not a temporary accident of the cosmos: it is the very condition that allowed vacuum, matter, and forces to emerge with stability. The presence of structure at any moment implies that the universe cannot possess a final state of absolute incoherence.

Moreover, accelerated expansion does not entail an ontological loss of structural capacity. Late-time vacuum may enter new regimes of organization, just as early-time vacuum supported the transitions that gave rise to stable matter. The dilution of current structures does not imply their definitive extinction, but their transformation. What disappears at one scale may reappear at another, just as stable matter arose from a universe initially without particles. Cosmological phase transitions are manifestations of the

persistence of coherence, not of its exhaustion.

Therefore, the PUR excludes the possibility of heat death understood as the universe's final state. Coherence does not extinguish itself: it reorganizes. Extreme expansion may alter the forms of structure, but it cannot annul the fundamental impulse that makes them possible. The universe's destiny is not terminal freezing, but the ontological continuity of being through successive transformations, in which the replication of coherence adopts new and still unknown modes.

Thus, without needing to postulate a specific cosmological scenario, the PUR requires only that coherence cannot be extinguished entirely. Even if the present forms of order transform, the ontological continuity of being cannot be broken.

8 Conclusion: The Ontological Continuity of Being

Having shown that the evolution of the cosmos cannot culminate in a state of incoherence or entropic exhaustion, we can now understand more clearly the deep logic that underlies its entire development.

The cosmos is not an isolated episode nor a succession of disconnected events, but the continuous expression of a fundamental impulse: the tendency of being to preserve, replicate, and amplify its coherence. From the primordial state of unified energy to the emergence of vacuum, matter, and conscious life, every phase of the universe manifests the same profound dynamic. The Principle of Universal Replication (PUR) does not introduce a new force, but names the essential property that makes it possible for stable laws, durable structures, and processes that perpetuate themselves to exist over time.

The origin of the cosmos may thus be understood as the first act of replication of the total coherence of being, which dilates into vacuum and stabilizes into matter. The dynamics that sustain galaxies, atoms, and organisms are not contingent, but the natural prolongation of that initial impulse. Coherence is not a late product of the universe: it is its constitutive condition.

This perspective also transforms our understanding of the cosmic destiny. Under the PUR, the global evolution of the universe cannot culminate in a final state of incoherence or thermal exhaustion. Extreme expansion may modify the forms of structure, but it cannot annul being's capacity to replicate itself in new modes. Coherence can shift from one scale to another, from one physical regime to another, just as stable matter emerged from a universe initially without particles. The cosmos is not headed toward a definitive fading, but toward future phases in which the ontological continuity of the PUR will continue to manifest in forms that are presently unknown.

The universe does not merely expand: it reiterates.
Energy does not merely persist: it prolongs itself.
Matter does not merely exist: it replicates.
And life is not an exception, but the conscious expression of cosmic coherence.

The Principle of Universal Replication reveals that reality is not grounded in chance, but in the continuity of being. Everything that exists—from an atom to a galaxy—is an act of repetition of the same originating impulse. The cosmos, in its totality, is the perpetual imprint of that coherence which never ceases to renew itself.