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The Living Universe

An Outreach of Natural Selection to the Entire Universe

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Abstract: This work explores the hypothesis that evolutionary dynamics analogous to Darwinian natural selection may extend beyond biological systems and operate throughout the physical Universe. Starting from the observation that living organisms themselves emerge from physical matter governed by universal laws, the study investigates whether principles such as variation, stability, persistence, selection, integration, and elimination may also characterize the evolution of elementary particles, atoms, stars, thermodynamic systems, spacetime, motion, and fundamental interactions.

A comparative analysis of multiple physical domains reveals recurrent organizational patterns compatible with cumulative evolutionary behavior. Across different physical scales, stable configurations tend to persist over long timescales, whereas unstable structures decay, transform, or disappear. Increasing complexity frequently emerges through the integration of pre-existing systems, similarly to the progressive organization observed in biological evolution. Atomic structures, stellar populations, thermodynamic regimes, and large-scale cosmic organization all appear to exhibit forms of structural selection constrained by environmental and energetic conditions.

Within this framework, spacetime, mass, motion, thermodynamic laws, and even the hierarchy of fundamental interactions are interpreted not necessarily as immutable entities established instantaneously at the origin of the Universe, but potentially as components of a progressively evolving physical system. The apparent separation between quantum and gravitational regimes may therefore reflect different organizational and evolutionary scales of the same underlying physical reality rather than fundamentally incompatible descriptions.

The proposed framework also suggests several possible conceptual implications for cosmology. These include the gradual co-development of matter and spacetime, the coexistence of overlapping evolutionary structures across cosmic history, and the possibility that certain observational tensions in modern cosmology may be compatible with cumulative and partially asynchronous evolutionary processes occurring over extremely long timescales. Similarly, cosmic expansion may be interpreted also as an ongoing evolutionary process involving the progressive differentiation and separation of matter within expanding spacetime.

The present hypothesis remains highly speculative and currently lacks a predictive mathematical formalism capable of generating quantitative physical predictions. The proposed interpretations should therefore be considered conceptual and heuristic rather than demonstrative physical models. Nevertheless, recent developments in particle physics, cosmology, and complexity science suggest that some aspects of matter formation and large-scale cosmic organization may already be compatible with dynamic and evolutionary interpretations of physical reality.

By proposing a common evolutionary language applicable across traditionally separated scientific domains, this work aims to stimulate interdisciplinary discussion among cosmology, theoretical physics, thermodynamics, complexity science, and evolutionary theory toward a broader understanding of the Universe as an evolving, multi-domain system.

Index Terms **- universe, evolution, natural selection, matter, spacetime, life.**

1. INTRODUCTION

The present hypothesis originates from the observation that biological life emerged within the physical Universe and is entirely composed of its fundamental constituents. Living organisms are built from atoms and molecules that themselves originated through earlier physical and chemical evolutionary processes. It is therefore reasonable to ask whether biological evolution and physical evolution may represent different manifestations of a single underlying developmental mechanism rather than fundamentally separate processes. From this perspective, the Darwinian principles of variation, selection, stability, persistence, and adaptation may not be restricted to biological systems alone, but could also apply to the physical components of the Universe, including elementary particles, atoms, stars, spacetime, motion, and fundamental interactions. The search for a common evolutionary framework arises from the possibility that matter, life, and physical laws belong to a continuous evolutionary system governed by shared organizational principles.

This interdisciplinary perspective is consistent with the complexity framework proposed by Morin (1977), who argued that physical, biological, and social phenomena should not be interpreted as isolated domains but as interconnected manifestations of common organizational processes operating across different scales of reality.

Several observational results in physics suggest that the Universe may have emerged and evolved more gradually than predicted by a single explosive event. Measurements from the Planck satellite show unusually low temperature fluctuations on the largest scales of the cosmic microwave background, a feature that may be more consistent with a slow departure from an initially near-static state than with an abrupt Big Bang origin (Planck Collaboration VI, 2020). Likewise, studies of the cosmic expansion rate based on the ages of distant galaxies indicate a smooth and progressive evolution of the Hubble parameter (Jiménez & Loeb, 2002; Moresco et al., 2016). In addition, the absence of detected primordial B-mode polarization places significant constraints on strongly violent inflationary scenarios (BICEP/Keck Collaboration, 2021).

Within this framework, one may hypothesize that the Universe originated from a near-equilibrium quasi–de Sitter vacuum state, in which quantum fluctuations continuously generated proto-particles with different physical properties. During the gradual expansion of spacetime, only those particles whose masses, charges, and interaction strengths were compatible with the evolving cosmic environment remained stable, while incompatible configurations decayed or disappeared. In this sense, the emergence of stable matter may be interpreted as a form of cosmic natural selection.

In this perspective, mass becomes one of the principal selection parameters governing the survival of physical systems. Quantum fluctuations may initially produce a broad spectrum of particles with different masses, but only those within specific stability windows can persist long enough to form increasingly complex structures. Electrons and light quarks, for example, occupy mass ranges compatible with the formation of protons, neutrons, nuclei, and atoms. Similarly, stable atomic nuclei correspond to configurations with favorable binding energies and reduced probability of spontaneous decay.

Within this hypothesis, evolution would not concern matter alone. Since mass, spacetime, motion, and energy are intrinsically connected through Einstein’s relativity, the same evolutionary principles may also apply to the fundamental physical interactions, to the structure of spacetime itself, and to the thermodynamic conditions governing the Universe. In this perspective, space, time, motion, and the fundamental forces are not interpreted as immutable background quantities, but as components of a single evolving system whose properties progressively emerge and stabilize together with matter. The recurring relations observed between stability, mass, interaction strength, lifetime, and structural complexity at different physical scales may therefore represent manifestations of a common evolutionary dynamics acting throughout the Universe.

2. RESEARCH METHODOLOGY

2.1 - General Principles of the Theory of Natural Selection

The theory of the evolution of species by means of natural selection, first formulated by Darwin (Darwin, 1859), predicts that the development of living forms is regulated by their interaction with the environment. Organisms exhibit heritable variation, and some variants confer a greater probability of survival and reproduction under specific environmental conditions (Lewontin, 1970; Gregory, 2009). Through differential reproductive success, adaptive traits become progressively more common within populations over generations.

Modern evolutionary theory identifies three fundamental conditions necessary for Darwinian evolution (Lewontin, 1970). Each is listed below along with its qualitative subcategories:

1. Variation among individuals
   a. Evolution frequently proceeds from relatively simple toward increasingly complex organizational forms (Maynard Smith & Szathmáry, 1995)
   b. Evolution proceeds through a multiplicity of stochastic events and “attempts,” distributed across populations and time. Natural selection acts statistically upon this variability, favoring forms with greater adaptive stability (Fisher, 1930; Wright, 1932)
   c. Many evolutionary forms and transitional stages disappear without leaving detectable traces, as extinction is an intrinsic component of evolutionary dynamics (Simpson, 1944)
2. Heritability of traits (incorporation of previous structural states into subsequent, more complex configurations)
   a. Certain evolutionary innovations are so successful that they are conserved indefinitely, either independently or incorporated into subsequent evolutionary stages. Examples include the atom, the cell, DNA, and fundamental metabolic pathways (Jacob, 1977)
   b. Evolutionary processes are strongly constrained by historical contingency: present forms depend on previous states and on irreversible developmental pathways (Gould, 1989)
   c. Complex systems frequently emerge through the integration and cooperation of previously independent entities (Margulis, 1970)
3. Differential fitness or reproductive success (persistence)
   a. Simpler systems are often more stable and persistent over long evolutionary timescales than highly specialized or highly complex systems (Gould, 2002)
   b. Evolution intrinsically contains both mechanisms of persistence and mechanisms of elimination. In biological systems this duality is represented by the life/death cycle, while in physical systems it may correspond to formation/decay dynamics (Prigogine & Stengers, 1984)
   c. Evolution does not necessarily imply progress toward perfection, but rather adaptation to local environmental conditions (Dobzhansky, 1973)

More generally, Darwinian systems operate whenever replication, variation, and selection coexist (Dennett, 1995). Evolution is therefore not a linear or predetermined process, but the emergent consequence of interactions between stochastic variation and environmental constraints (Monod, 1971). Adaptation arises through the continuous filtering of biological diversity by natural selection, while extinction removes forms that are unable to persist under changing conditions.

These principles suggest that evolution represents a general mechanism of organization operating through the interaction between variation, selection, stability, and transformation. Originally formulated for biological evolution, these principles may also be theoretically generalized to physical systems if the concept of "individual" is extended to physical structures, interaction regimes, and organizational states of matter and spacetime. In this framework, elementary particles, atoms, stars, motion, time, fundamental forces, and thermodynamic systems may be interpreted as evolving configurations subjected to stability selection throughout cosmological development.

Translating the concept of "living organism" into the broader concept of "constituent of the Universe," it is theoretically possible to apply these evolutionary principles to the known structures composing the observable Universe, in order to investigate whether analogous evolutionary dynamics can also be identified in physical systems.

In this context, the "environment" corresponds to the physical Universe governed by the known laws of quantum mechanics, thermodynamics, and relativity. This environment acts as the general framework within which elementary particles, atoms, stars, galaxies, planetary systems, and biological organisms emerged and evolved.

We propose that a continuous sequence of development processes links all existing structures, from elementary particles to galaxies and biological systems, suggesting that all components of reality may be interconnected and subject to analogous organizational principles. A dynamic balance between chance and necessity (Monod, 1971), regulated through selective stability and interaction mechanisms, may have contributed to the emergence of the present structure of the Universe along a common, interconnected evolutionary trajectory.

2.2 - Application of the Theory of Natural Selection to the Components of the Universe

This work explores the hypothesis that the Universe evolves through a progressive and simultaneous development of spacetime, matter, and organizational complexity, in agreement with relativistic cosmology (Einstein, 1916), following a natural selection method like biological beings.

Since mass is one of the principal properties distinguishing physical structures, the components of the Universe can be arranged along a scale of increasing mass and complexity, extending from elementary particles to atoms, stars, galaxies, planets, and biological systems. In this framework, increasing mass corresponds not only to increasing size, but also to increasing structural organization and functional differentiation.

If the Universe evolved progressively, it is conceivable that the interactions governing physical systems also underwent evolutionary transformations. Consequently, the physical laws and fundamental interactions observed today may represent stable configurations emerging from earlier dynamical states of matter and spacetime.

Within this perspective, the analysis concerns not only material structures but also the functional mechanisms regulating them. Therefore, both physical entities and functional principles are considered among the major components of the Universe (and relative paragraph):

- elementary particles (3.1);
- atoms (3.2);
- stars and stellar systems (3.3);
- motion (3.4);
- time (3.5);
- fundamental interactions (forces) (3.6);
- thermodynamic laws (3.7);

The most significant correlations and characteristics emerging from this analysis are reported. At the end of the specific analysis, a summary table (paragraph 3.8) of the three fundamental evolutionary mechanisms applied to the components of the Universe will highlight the correspondences and the applicability of this theory.

2.3 - Terminological clarification: conceptual use of biological terms

2.3.a - Evolution

In the present work, the term "evolution" is used in a broad heuristic and organizational sense rather than as a strict biological equivalence. Within modern cosmology, regardless of the specific theoretical framework adopted, the observable Universe is understood not as a static and eternally unchanged system, but as a physical reality that progressively developed into its present structure through successive transformations of matter, energy, spacetime, and large-scale organization. In this context, the term "evolution" is employed primarily as a concise synonym for "development" or "progressive transformation" of the Universe across cosmic history.

The choice of this terminology also reflects the fact that biological evolution, as formulated in Darwinian theory, represents one of the most universally recognized scientific paradigms describing cumulative change, selection, persistence, adaptation, and increasing organizational complexity over time. Consequently, the word "evolution" carries an immediate conceptual meaning that facilitates interdisciplinary interpretation. Furthermore, the historical development of evolutionary theory itself — initially controversial and strongly opposed, yet progressively consolidated through overwhelming empirical evidence — parallels the historical trajectory of several major cosmological theories that similarly emerged through critical debate and observational validation.

For these reasons, the use of the term "evolution" in the present study is intended as a respectful and conceptually meaningful extension of an established scientific language, while fully acknowledging the important distinctions between biological evolution and cosmological development. More than a definition, it expresses a concept and, as such, it may also be used in contexts that are not strictly nominal.

2.3.b - Lineage

The term "lineage" is employed in an extended conceptual sense beyond its strictly biological meaning. In biology, a lineage describes a sequence of organisms, populations, or species connected through descent, continuity, and progressive transformation across time. Here, the term is used analogously to describe recurrent physical sequences or families of structures that exhibit progressive organization, shared properties, transitional states, and continuity of configuration within the evolution of physical systems.

The use of “lineage” does not imply literal biological ancestry, reproduction, or genetic inheritance among physical entities, but rather refers to ordered developmental relationships and persistent structural continuity observed across different physical scales. In this context, atomic series, stellar classes, thermodynamic regimes, interaction hierarchies, or recurrent dynamical configurations may be interpreted as “physical lineages” insofar as they represent successive organizational states connected through gradual transformation, stability selection, and increasing complexity. The term is therefore adopted as a heuristic and interdisciplinary conceptual tool intended to emphasize continuity and progressive structural organization within the evolutionary framework proposed in this study.

2.3.c – Living being

The concept of a “living being” is considered from a broad organizational perspective rather than a strictly biological one. Biological organisms are commonly regarded as living because they emerge, persist, interact with their environment, undergo continuous transformation, pass through recognizable developmental stages, and ultimately disappear through irreversible processes. Similar characteristics can also be identified in many physical systems.

The Universe is not a static entity: it possesses a history, changes through time, and continuously generates, transforms, and reorganizes structures across multiple scales. Elementary particles, atoms, stars, galaxies, and larger cosmic structures exhibit identifiable cycles of formation, persistence, interaction, transformation, and decay.

As in biological ecosystems, the Universe simultaneously contains entities of different ages and at different stages of their life cycles, from newly formed structures to mature, stable, and decaying ones. Recurring organizational patterns appear across physical scales, while more complex systems often incorporate and preserve components originating from earlier stages.

From this perspective, the term “living” is used as a conceptual descriptor for systems characterized by dynamic persistence, developmental history, structural transformation, and coexistence of multiple life-cycle stages. Within this framework, biological organisms may represent a particular manifestation of a more general organizational principle that also characterizes the physical Universe and its constituent structures.

3. RESULTS

3.1 Elementary Particles Evolution

In particle physics, an elementary or fundamental particle is a subatomic particle that is not composed of smaller constituents. Elementary particles include fermions (quarks and leptons), gauge bosons, and the Higgs boson, while particles composed of two or more elementary particles are called composite particles.

Following the hypothesis that space, time, and mass evolve simultaneously, particles with lower mass may represent the most primordial and stable forms of matter, whereas heavier particles appeared later within an expanding spacetime framework.

Figure 1 shows the distribution of known elementary particles according to their mass and lifetime.

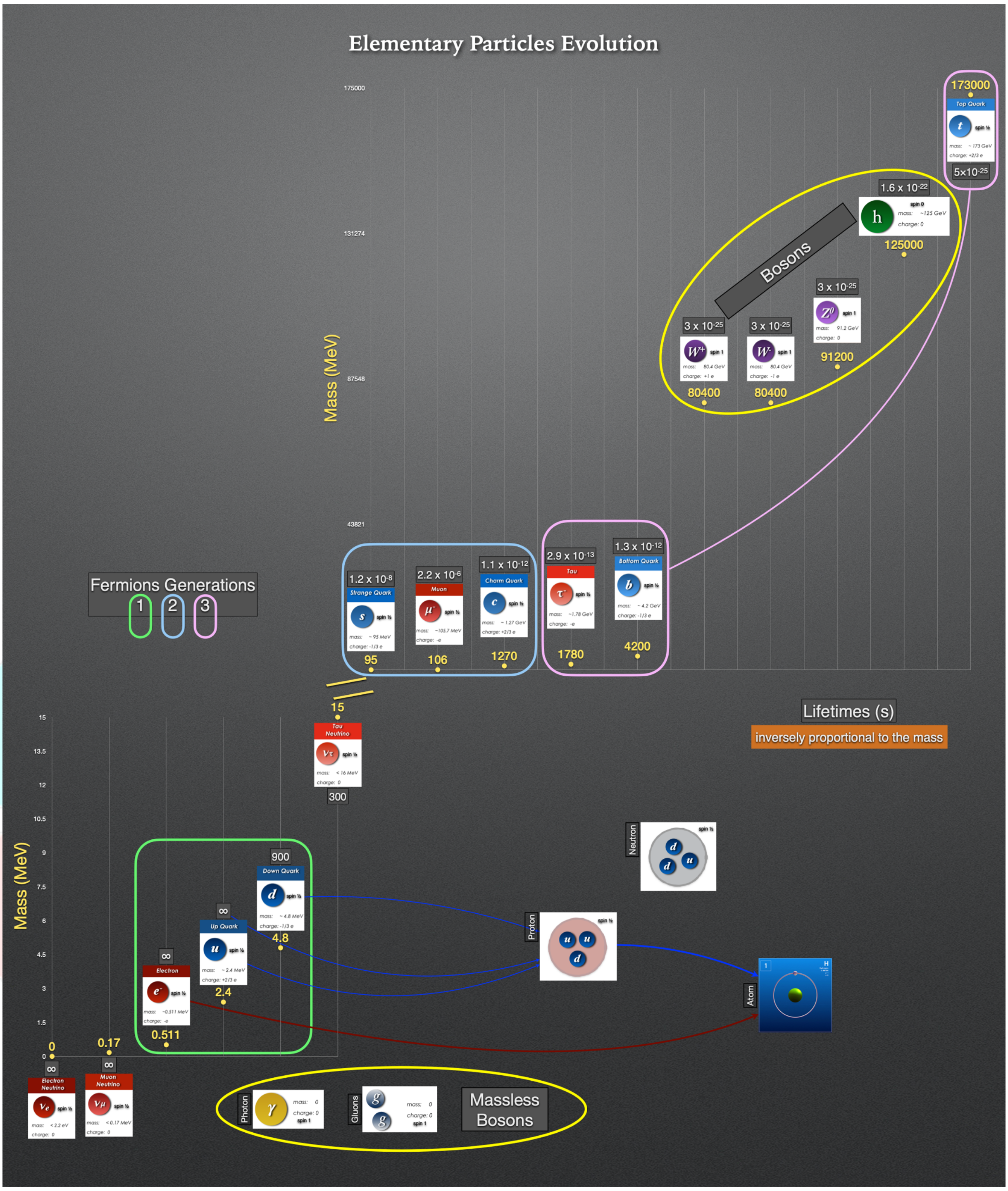

Figure 1 - Graph representing the increasing mass distribution of known elementary particles (in MeV) on the ordinate; the lifespan of the particles is shown in the abscissa.

- A clear inverse relationship between mass and lifetime can be observed: lighter particles generally have longer lifetimes, while heavier particles decay rapidly. The electron, with a mass of 0.51 MeV, is essentially stable, whereas the Top Quark, with a mass of about 173 GeV, survives only about $5\text{x}10^{-25}$ s. This behavior suggests that simpler and lighter particles are more stable because they undergo fewer perturbations, while heavier and more complex particles are intrinsically less stable and decay more easily. Nevertheless, unstable particles still play essential roles in maintaining the dynamics of the system. Gluons act as carriers of the strong interaction, while the Higgs boson is associated with the origin of particle masses. In this sense, even short-lived particles contribute to the evolution and stability of matter. An analogy can be found in biological evolution, where short-lived genetic variations increase diversity and adaptability. Similarly, unstable particles contribute to transformation processes through their decay and energy release.
- Some particles do not decay into smaller constituents and can therefore be considered stable. These include massless particles such as photons and gluons, as well as particles with extremely small masses, such as electron and muon neutrinos. These particles are electrically neutral and interact weakly with matter.

- Among the massive particles, the first generation of fermions — electron, Up Quark, and Down Quark — became the stable constituents of atomic matter. Quark combinations form protons (*u-u-d*) and neutrons (*d-d-u*), while the electron remains an independent stable particle.
- An important aspect is that the Down Quark, although characterized by a finite lifetime, becomes effectively stable once confined inside the proton. This represents a possible evolutionary mechanism in which aggregation increases stability and preserves structures that would otherwise decay. Similar mechanisms are found at larger scales in physical and biological systems, such as nuclear fusion in stars or endosymbiotic processes in biology.
- The second and third generations of fermions are considerably heavier and much more unstable than the first generation. Among bosons, the W^+, W^-, and Z^0 particles show similar masses and lifetimes, whereas the Higgs boson differs significantly from the others, similarly to the Top Quark among fermions. Particles that strongly deviate from the average properties of their families may represent important transition states in the evolution of matter. A similar mass–lifetime relation is also observed at larger scales of nature: massive stars consume energy more rapidly and therefore have shorter lifetimes than smaller stars. This recurring behavior suggests that stability in nature is generally associated with lower mass and lower energy configurations. According to this interpretation, the simultaneous evolution of mass and spacetime may impose limits on excessive mass concentration within a finite spacetime structure.
- The other elementary particles are extremely labile and have an extremely short lifespan (10^{-8} - 10^{-25} seconds). Their "survival" is also linked to the release of energy upon their "death," facilitating other processes: the same modality that we find in the nuclear fusion process and in the life cycle of the stars. The masses of the second and third generations of fermions are far greater than the first with small differences between the various particles, except for Top Quark, which has a mass that "exceeds" also the bosons. Three of the latter (W^+, W^-, and Z^0) are similar to each other in mass, spin and lifetime; the fourth (Higgs) also differs greatly from the previous ones, as happens in the third generation of fermions. Particles that "break away" from the average of their respective families also have fundamental importance in particle physics. They are probably important evolutionary transitions or links between them.

3.2 - Evolution of the atom

Figure 2 shows the distribution of atoms according to increasing atomic number and mass, together with their main physical properties: density, atomic radius, charge states, isotopes, abundance, and stellar origin. The data suggest the presence of recurrent structural patterns that may be interpreted as evolutionary trends in atomic organization.

- Atomic mass and complexity increase progressively from hydrogen to uranium (increase of atomic number Z).
- Atomic abundance generally decreases with increasing atomic number: lighter elements are more common in the Universe, whereas heavier elements are progressively rarer.
- The atomic radius shows a repetitive periodic behaviour marked by noble gases. After each noble gas, the radius increases again and then progressively decreases along the following sequence.
- Similar periodic patterns are also observed for density, charge distribution, isotope number, and abundance, suggesting the presence of recurrent atomic "lineages".
- Noble gases represent particularly stable configurations because of their electronic structure and appear as transition points between successive atomic lineages.
- Seven atomic lineages can be identified:
    - He lineage: H–He
    - Ne lineage: $Z = 3–10$
    - Ar lineage: $Z = 11–18$
    - Kr lineage: $Z = 19–36$
    - Xe lineage: $Z = 37–54$
    - Rn lineage: $Z = 55–86$
    - Og lineage (partially synthetic): $Z = 87–118$.

- The first lineage contains the most abundant elements of the Universe, hydrogen and helium, supporting their primordial origin. Heavier lineages contain progressively larger and denser atoms, while the reduction of atomic radius within each lineage becomes less pronounced.

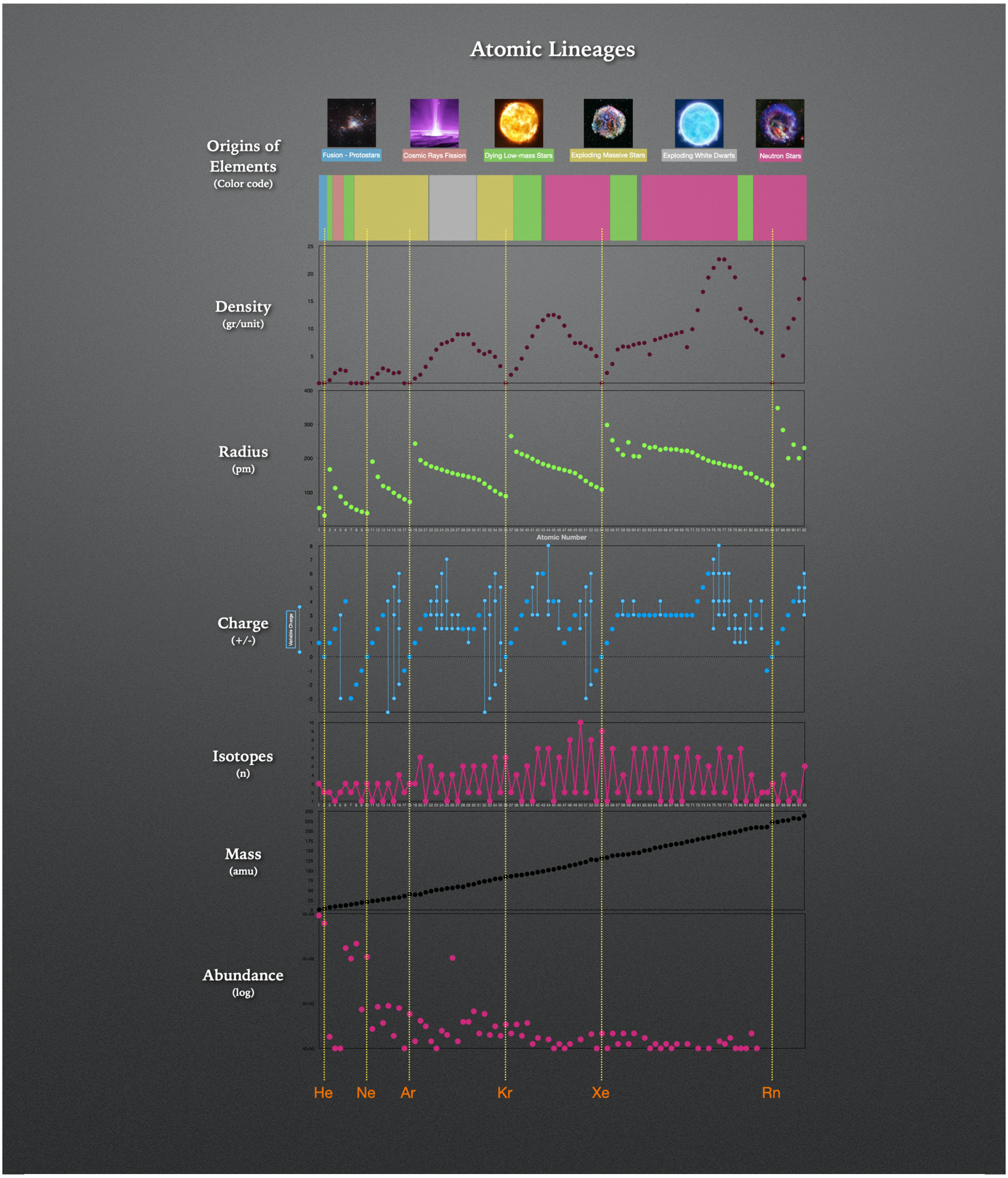

Figure 2 - Distribution of atoms by increasing mass (atomic mass unit) as a qualitative representation of recurrent organizational patterns in atomic systems. The atomic number (Z) is shown twice for convenience within the graph (in light gray) and used to identify the atoms. Density, radius, electric charge, isotopes and relative abundance are represented in overlapping graphs aligned by atomic number. A color code identifies the origin of the various atoms at the top of the graph. Noble gases are shown at the bottom of the graph.

- Positive charge states become more common in heavier atoms, whereas negatively charged states progressively decrease. This may favor the formation of chemical bonds and complex compounds.
- The number of isotopes generally increases in intermediate and heavy elements, indicating greater structural variability within the limits of the Valley of Stability.
- Radioactive decay appears in very heavy atoms outside the stability valley. In this process, unstable nuclei progressively transform into lighter and more stable elements.
- Uranium and other heavy radioactive atoms therefore represent unstable evolutionary stages rather than permanent configurations.

- The figure also highlights the stellar origin of the elements: hydrogen and helium mainly originated from primordial fusion processes; light elements were generated by fusion and fission processes in early stellar evolution; many intermediate elements derive from low-mass stars through long stellar life cycles; massive stars contributed mainly to the production of elements formed during rapid stellar evolution and supernova explosions; neutron stars contributed predominantly to the formation of the heaviest elements of the periodic table.

Overall, the atomic distribution shows recurring periodicity, increasing complexity, and stability limits. The transition from lighter stable atoms to heavier unstable ones resembles an evolutionary process in which only specific configurations remain stable over long timescales, while unstable configurations decay into simpler and more stable forms.

3.3 - Evolution of Stars and Stellar Systems

Unlike atoms, stars cannot be easily organized into precise evolutionary lineages because their observable properties change significantly during their life cycle. Stellar luminosity, temperature, radius, and spectral characteristics vary continuously with stellar evolution, while the internal structure of stars cannot be directly observed. In addition, molecular clouds obscure the earliest stages of stellar formation, stellar evolution occurs over billions of years, and no direct experimental reproduction of stars is possible.

Observing stellar populations in the Universe is analogous to examining a single group photograph containing individuals from every stage of life simultaneously — infancy, childhood, adolescence, adulthood, and old age. In such a picture, one may identify many children, students, and adults, yet it is impossible to determine which adult corresponds to which child observed earlier in time. Stellar astronomy faces a similar limitation: we observe stars belonging to many different evolutionary phases at once, but we cannot directly follow the complete life cycle of any individual star because stellar evolution occurs over billions of years. Consequently, the evolutionary sequence of stars must be reconstructed indirectly by comparing different stellar populations observed in distinct stages and arranging them into a coherent developmental framework. This process is further complicated by the difficulty of distinguishing truly primordial stars — formed during the earliest phases of cosmic evolution — from stars that are simply young within their individual stellar life cycle.

Figure 3 summarizes the main stellar properties arranged by increasing stellar mass and compared with the spectral classification introduced by Payne (Payne, 1925). The graph includes abundance, lifetime, temperature, radius, spectral lines, and metallicity.

- When stars are ordered by increasing mass, the sequence of spectral classes becomes: M-K-G-F-A-B-O which is the reverse of the traditional Payne classification based on decreasing temperature.
- Low-mass stars (M class) are the most abundant stars in the Universe. They are characterized by: low temperature, small radius, high metallicity, weak hydrogen spectral lines, extremely long lifetimes, exceeding the current age of the Universe.
- K-type stars are less abundant and less long-lived, while maintaining intermediate physical properties between M stars and the hotter stellar classes.
- From G to O classes, stellar properties vary progressively: increasing mass and radius, increasing temperature, decreasing metallicity, decreasing lifetime.
- Massive stars consume nuclear fuel more rapidly and therefore evolve faster, similarly to the inverse mass–lifetime relation observed for elementary particles and unstable atoms.
- A-type stars show particularly strong hydrogen spectral lines mixed with ionized metals such as Fe II, Mg II, and Si II.
- B- and O-type stars show weaker hydrogen lines but stronger helium spectral signatures, indicating higher internal energies and temperatures.
- The most massive stars are also the least metal-rich and exhibit the greatest variations in temperature and radius.
- Older and long-lived stellar populations (M and K classes) appear richer in metals, whereas younger and massive stars remain dominated by hydrogen and helium.
- Iron is particularly significant because of its relatively high abundance compared with neighboring elements, suggesting an important role in stellar and atomic evolution.
- The distribution of stellar properties suggests progressive transitions rather than sharply separated stellar populations, similarly to the gradual variation observed in atomic lineages.

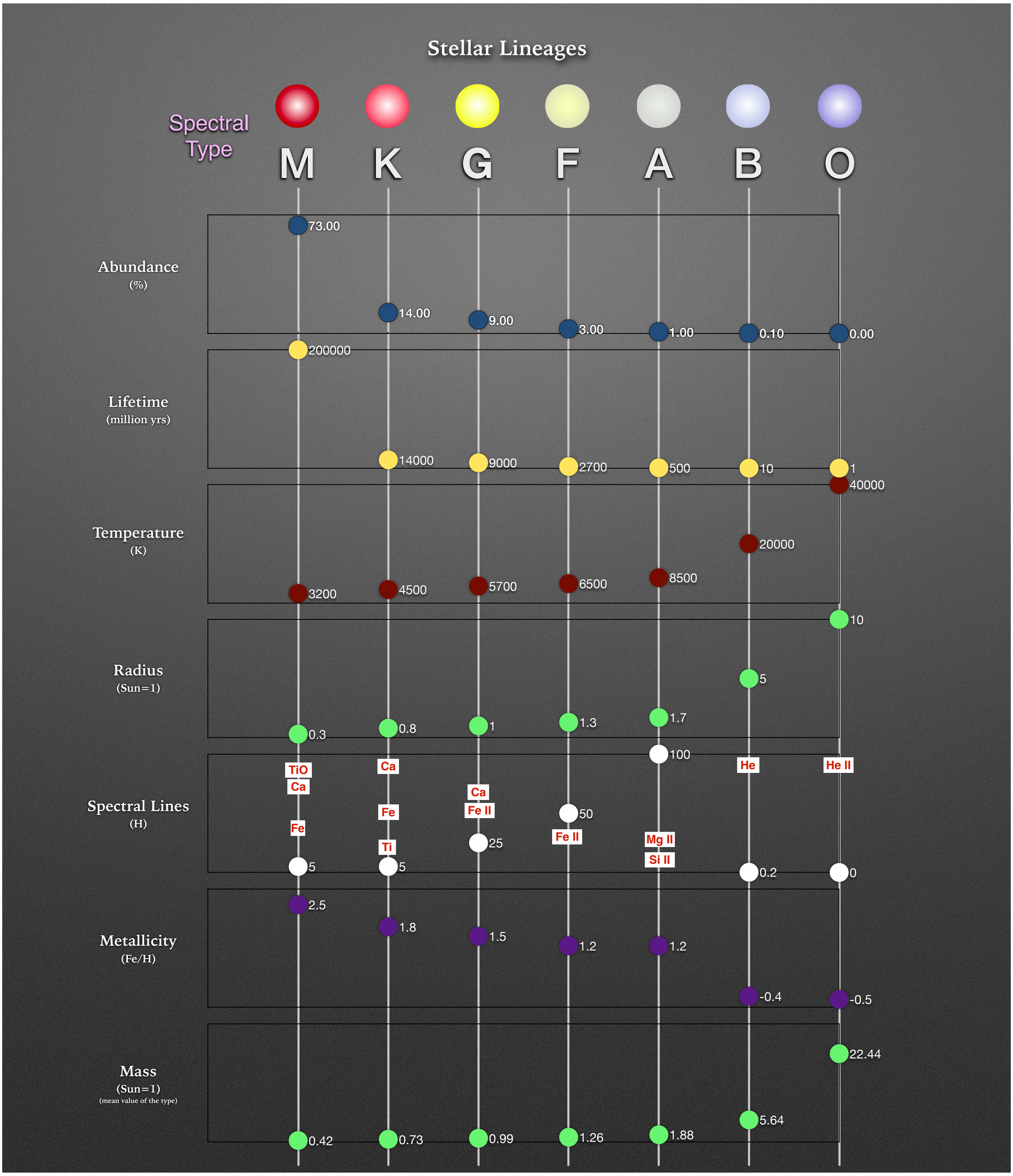

Figure 3 - Graph of the main stellar features sorted by increasing mass. Spectral classes of stars according to Payne's classification, abundance, lifetime, temperature, radius, main spectral lines and metallicity are represented in overlapping graphs and aligned by increasing relative stellar mass. Abbreviations: Ca, calcium; Fe, iron; He, helium; Mg, magnesium; Si, silicon; TiO, titanium oxide.

3.3.a - Stellar Decay – Stellar Life Cycle

The "death" of a star is fundamentally different from atomic decay. While unstable atoms decay into other well-defined atoms, stellar evolution generates entirely new astrophysical structures and chemical elements.

Stars represent a major evolutionary step because nuclear fusion transforms primordial hydrogen and helium into heavier elements ("metals"). Stellar evolution therefore increases both the chemical diversity and structural complexity of the Universe.

The death of stars through supernovae and related processes produces:

* heavier atomic elements;
* neutron stars and white dwarfs;
* planetary systems;
* enriched interstellar matter from which new stars may form.

In this sense, stellar evolution acts as a mechanism of amplification of cosmic variability and complexity. Without stellar nucleosynthesis, the Universe would have remained dominated by hydrogen and helium, preventing the later emergence of planets and biological life.

3.3.b - Metallicity

The relationship between stellar age and metallicity remains uncertain. Observations show large metallicity variations among stars of similar age, suggesting that metal enrichment did not occur linearly throughout cosmic history. One possible interpretation is that metals were already produced during very early and relatively disorganized stages of stellar formation, before the appearance of stable stellar populations. Subsequent generations of stars then progressively mixed and redistributed these elements through supernova explosions and stellar winds.

This could explain:

* the large metallicity dispersion observed in galaxies and star clusters;
* the presence of significant carbon abundances in very early galaxies;
* the relatively low abundance of lithium, beryllium, and boron compared with carbon, nitrogen, and oxygen.

According to this interpretation, stellar evolution may have proceeded through increasingly energetic and organized stellar systems, progressively amplifying the production of heavier and more stable elements as spacetime, mass, and complexity increased together.

3.4 - Evolution of Motion

Motion is one of the most difficult physical concepts to define independently, because it is intrinsically related to both space and time. Without space there can be no displacement, and without time no displacement can occur. Motion therefore reinforces the concept of spacetime as a unified physical entity, consistent with Einsteinian relativity, where space and time represent complementary aspects of the same system. Since spacetime itself is linked to mass, motion may also be considered part of the same evolving physical framework.

Within the evolutionary hypothesis proposed in this work, motion represents one of the first fundamental consequences of the emergence of mass and spacetime. If the primordial particle had remained static, no interaction, differentiation, or structural development could have occurred. Motion enabled separation, repetition, collision, and interaction between physical entities, thereby providing the basis for the subsequent evolution of the Universe.

In physics, motion is defined as the variation of the position of an object relative to its surroundings over time. Its description involves distance, displacement, velocity, acceleration, and reference frames — quantities that constitute the foundation of classical and relativistic mechanics. From an evolutionary perspective, motion can therefore be interpreted as a positively selected property because it allows the emergence of increasingly complex physical structures.

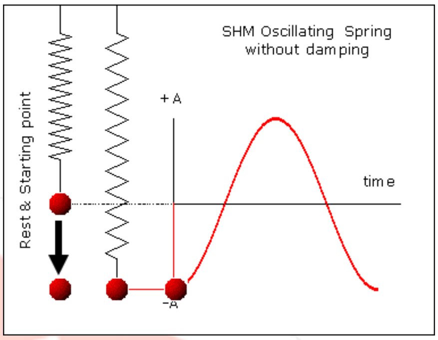

Figure 4: Transition from rebound motion to oscillatory motion, if occurring in a two- or three-dimensional system (small spacetime or larger spacetime).

A progressive evolution of motion may be hypothesized in parallel with the expansion of spacetime itself. In the earliest and most confined conditions, only extremely simple oscillatory motions may have been possible: a primordial "back-and-forth" displacement around an equilibrium position. Such motion would correspond to a minimal harmonic oscillation within an initially limited spacetime geometry.

As spacetime progressively expanded, these oscillatory motions could repeat with increasing regularity and frequency, generating periodic harmonic motion (Figure 4). The enlargement of spacetime also allowed motion along multiple spatial directions, enabling the transition from simple oscillation to wave propagation. In this stage, motion no longer remained confined locally but propagated through spacetime as organized periodic disturbances. Mechanical waves required interaction between particles, whereas electromagnetic waves could propagate directly through vacuum.

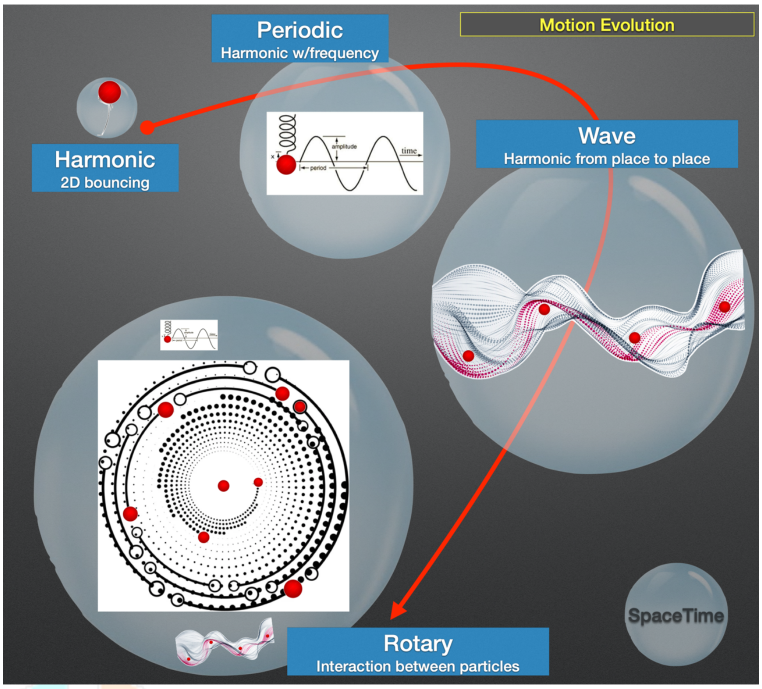

Figure 5: Illustrative representation of recurring dynamical configurations observed across multiple physical scales. The figure emphasizes the persistence and hierarchical organization of motion patterns throughout the evolution of the Universe. Graphic work by the Author.

A further evolutionary step of motion was rotational dynamics. Initially, rotation may have appeared at the microscopic level as particle spin, then progressively extended to interactions between neighboring particles and larger structures (Figure 5). Rotational motion became increasingly stable and conserved throughout cosmic evolution.

The atom represented a major consolidation of rotational dynamics. Since then, rotational motion has remained ubiquitous across all physical scales: electrons orbit atomic nuclei, planets orbit stars, and stars orbit galactic centers. Similar rotational structures recur repeatedly throughout the Universe at progressively larger scales (Sun, 2024). This persistence suggests that rotational motion constitutes one of the most stable and positively selected dynamical configurations in cosmic evolution.

3.5 – Evolution of Time

Within the framework proposed in this work, the primordial singularity may be interpreted not only as an origin of mass and spacetime, but also as the origin of time itself. The first “instant” could correspond to an infinitesimal temporal interval — for example a yoctosecond (10^{-24} s), or more fundamentally a Planck time (10^{-43} s) — representing the minimum spacetime unit required for the displacement of a particle and therefore for the existence of motion and mass.

In this perspective, time initially consisted of a single elementary “now.” The repetition of this primordial state generated the succession of moments perceived as temporal flow: now–now–now… (Figure 6). Without repetition, the primordial event would have remained isolated and no physical evolution could have occurred. Time may therefore be interpreted as an emergent consequence of repetitive physical processes occurring within spacetime.

The evolution of spacetime progressively increased the number of possible interactions, motions, and configurations available to the system, making time itself progressively “observable” and measurable. In the earliest stages, only extremely simple repetitive events may have existed, corresponding to minimal oscillatory processes within a highly confined spacetime geometry. As the system evolved, these elementary repetitions multiplied and diversified together with matter, motion, and physical interactions.

According to this interpretation, each individual “moment” contains the same fundamental physical parameters already discussed: motion, mass, charge, interaction, and

Figure 6: Conceptual representation of time as a repetition of singular moments.

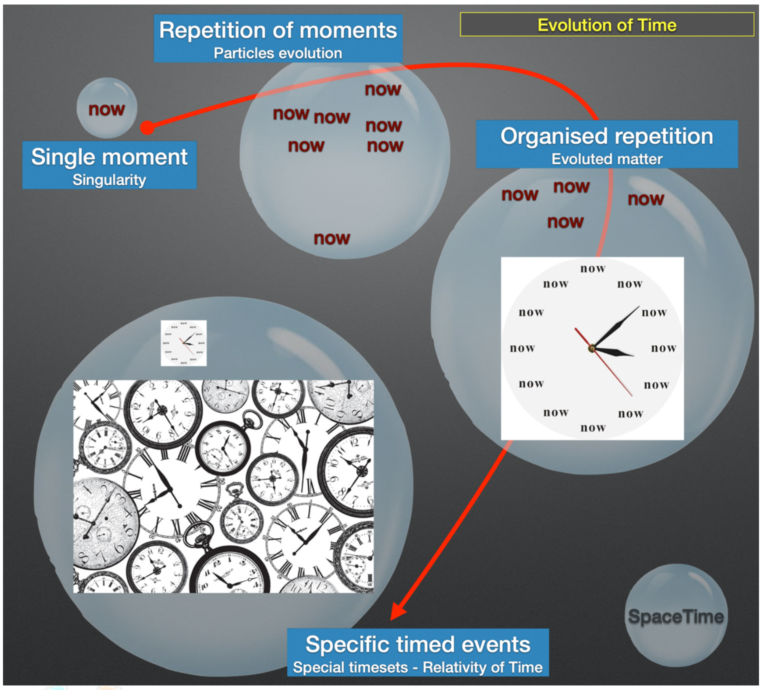

Figure 7: Emergence of temporal organization in physical systems. Conceptual representation of how increasingly stable and recurrent physical processes generate progressively more sophisticated forms of temporal organization across different physical scales. Graphic work by the Author.

energy. The elementary stage of time therefore corresponds to a minimal spacetime configuration capable of supporting these properties. Evolution acts by repeating and amplifying such elementary configurations, similarly to the repetition and stabilization processes observed for particles, atoms, and stellar systems (Figure 7).

This framework also suggests that time may fundamentally possess a repetitive rather than linear structure. Temporal organization emerges from the persistence and stabilization of recurring physical dynamics. Repetition therefore becomes a general mechanism of stability and persistence across all scales of the Universe (survival).

3.6 – Evolution of Fundamental Forces

A central hypothesis of this work is that the fundamental interactions and physical laws of the Universe may themselves be evolutionary entities, developing progressively together with spacetime, matter, and motion. In this framework, the laws observed today are not interpreted as immutable and fully established from the beginning, but as the result of a gradual cosmic evolution in which different interaction regimes emerged as the Universe increased in size, complexity, and structural diversity.

At the earliest stages of the Universe, only extremely simple configurations of spacetime and matter may have existed. Under such conditions, physical interactions would necessarily have operated over minimal spatial scales and between highly confined particles. The primordial system was therefore likely dominated by quantum behavior and by interactions analogous to what we now describe as strong nuclear dynamics (Bohr, 1915). As spacetime progressively expanded, matter differentiated into increasingly complex structures, and the effective behavior of interactions also evolved. Earlier interaction regimes, however, were not eliminated: once positively selected because compatible with the stability of the system, they remained conserved within later evolutionary stages. In this sense, the coexistence of strong nuclear interactions and gravitation in the present Universe may reflect different evolutionary layers of the same underlying physical process (Table 1).

Table 1: Evolutionary ordering of the four fundamental forces, from strongest to weakest (oldest to newest); force intensity is decreasing in relation to the development of the spacetime system (same force interaction 'diluted' in an increasing spacetime).

Force	Relative Strength	Range (m)	Carrier Particle	Evolutive Stage
Strong Nuclear	1	10^{-15}	Gluons	Elementary particles
Electromagnetic	10^{-2}	∞	Photon	Atom
Weak Nuclear	10^{-13}	10^{-18}	W and Z bosons	Molecules
Gravity	10^{-39}	∞	Graviton (theorized)	Celestial bodies

This perspective suggests that the apparent hierarchy of interaction strengths may correspond to successive evolutionary stages of the Universe. The strong nuclear interaction, which dominates at subatomic scales (relative strength ≈ 1), would represent the most primordial and localized interaction regime. Electromagnetic interactions ($\approx 10^{-2}$) and weak nuclear interactions ($\approx 10^{-13}$) would emerge at later stages characterized by increasing spacetime extension and greater structural variability.

Gravitation ($\approx 10^{-39}$), although apparently the weakest interaction at microscopic scales, becomes dominant over cosmological distances, organizing galaxies and large-scale structures.

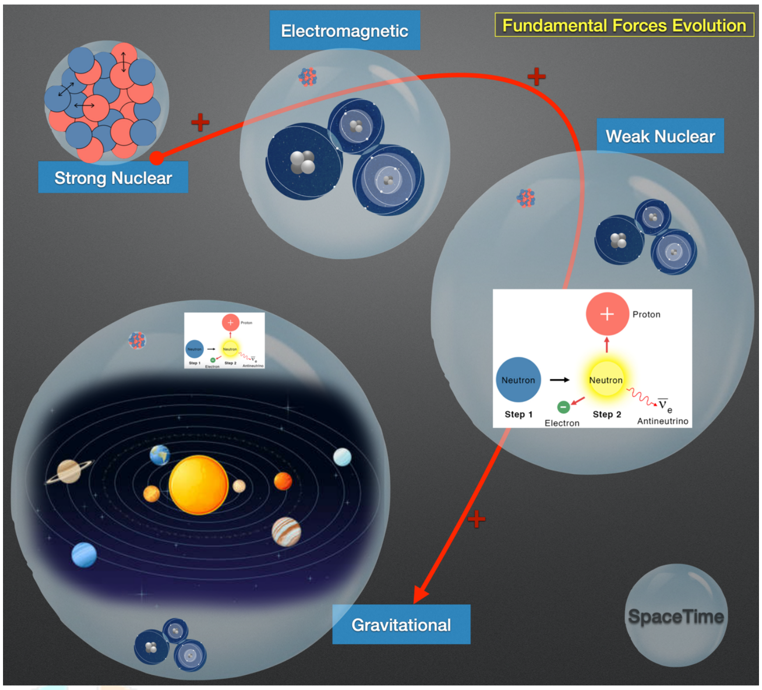

Figure 8: Scale-dependent dominance of physical interactions across organizational regimes. Conceptual illustration of how different physical interactions dominate at different spatial and structural scales. Graphic work by the Author.

Within this evolutionary interpretation, the progressive weakening of interactions is not viewed as a loss of physical importance, but rather as a consequence of the increasing expansion of spacetime itself. In the primordial Universe, spacetime may have been too limited to allow particles to separate significantly, requiring extremely strong local interactions to maintain stability. As spacetime expanded, interactions capable of acting over progressively larger scales became positively selected because they allowed the emergence of increasingly complex and stable structures.

This process may be conceptually analogous to endosymbiosis in biology, where previously independent systems (mitochondria, chloroplasts) become integrated into larger and more complex organizations while maintaining their original internal rules (Margulis, 1970), as part of a mutually beneficial relationship. Similarly, earlier physical interactions remain preserved within later structures: atomic nuclei continue to obey strong nuclear dynamics, while atoms, stars, galaxies, and larger cosmic systems are simultaneously governed by gravitational interactions.

From this perspective, the transition between quantum and gravitational regimes may not represent a discontinuity between incompatible theories, but rather different evolutionary manifestations of the same spacetime–mass system (Figure 8).

The gravitational interaction, commonly defined as extremely weak (Newton, 1686), nevertheless governs structures extending across galactic scales, such as the Milky Way, whose diameter is approximately (10^{21} m). By contrast, atomic dimensions are on the order of (10^{-10} m). The enormous difference in scale suggests the possibility that gravitation and strong nuclear interactions may correspond to analogous organizational principles operating at different evolutionary levels of spacetime expansion.

Although highly speculative, this hypothesis proposes that the apparent fragmentation of modern physics into quantum mechanics and gravitation may emerge from observing different evolutionary stages of a single underlying physical reality. The present hypothesis does not necessarily imply that the fundamental constants themselves vary arbitrarily over time, but rather that different interactions become dominant at different evolutionary scales of the Universe.

3.7 – Evolution of Thermodynamic Laws

The laws of thermodynamics may represent one of the deepest structural foundations of the Universe, since they govern energy, entropy, equilibrium, and the transformations of matter. Within the evolutionary framework proposed in this work, thermodynamic laws themselves may not be interpreted as static principles established simultaneously, but rather as successive dynamical regimes emerging during the progressive evolution of spacetime, mass, and energy.

If the primordial Universe originated from an almost null-energy state, then the earliest condition of the system may have approached absolute zero (0 Kelvin), corresponding to a configuration of maximal order and minimal entropy. Under such conditions, the physical state of the Universe would primarily correspond to what is now described by the third law of thermodynamics: a limit state in which thermal motion becomes minimal and the system approaches complete energetic uniformity. In this perspective, the third law may describe not merely an abstract thermodynamic limit, but the primordial condition of the Universe itself.

Following the initial perturbation associated with the singularity, entropy would progressively increase together with the expansion of spacetime and the emergence of matter interactions. The system thus entered a more dynamic evolutionary regime governed by irreversible energy transfer processes, corresponding to what is presently described by the second law of thermodynamics. Energy gradients, heat exchange, and irreversible transformations became possible only after the appearance of increasingly differentiated structures. Absolute zero consequently became progressively unattainable, remaining only as a limiting condition associated with the earliest evolutionary stage of the Universe.

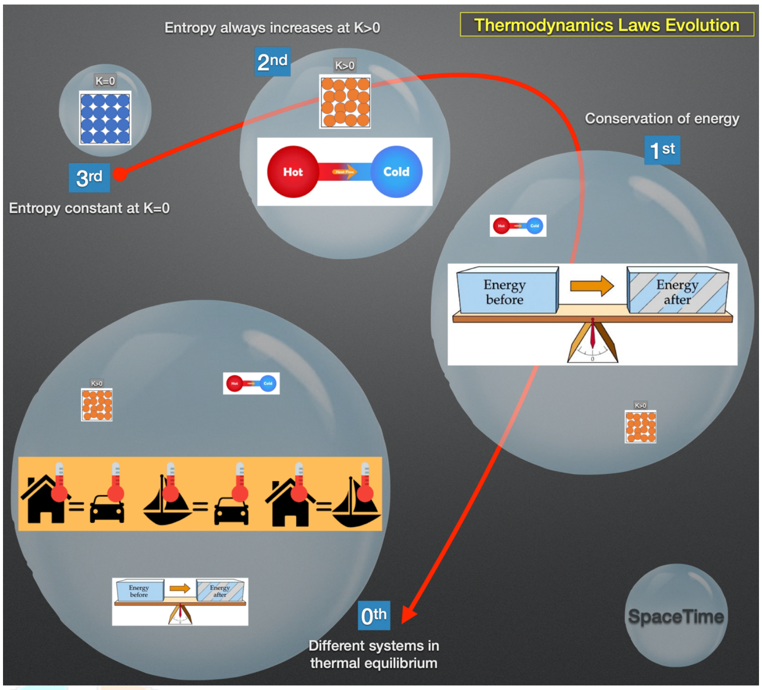

Figure 9: Thermodynamic regimes associated with increasing structural complexity. Conceptual representation illustrating how different thermodynamic descriptions become increasingly relevant in progressively differentiated systems. Blue labels indicate the laws of thermodynamics. Graphic work by the Author.

The present cosmological state is instead approximately described by the first law of thermodynamics, according to which the total energy of an isolated system remains conserved. Although it remains unknown whether spacetime and mass continue to emerge beyond the observable Universe, within the presently accessible cosmos the first law appears to describe the dominant large-scale energetic behavior.

The so-called zeroth law of thermodynamics may represent an even later evolutionary stage, since it requires the existence of multiple interacting systems capable of reaching mutual thermal equilibrium. Such a condition can emerge only in a sufficiently evolved Universe containing stable structures, repeated interactions, and long-term thermodynamic balance. In this interpretation, the zeroth law describes an advanced stage of cosmic evolution characterized by the stabilization of energetic exchanges among complex systems (Figure 9).

Within this framework, the thermodynamic laws are not replaced during evolution, but persist simultaneously as descriptions of different physical regimes generated during successive stages of cosmic development. Earlier states remain embedded within later structures, similarly to the persistence of quantum interactions within atoms or rotational dynamics within celestial systems. Thermodynamic evolution therefore appears cumulative rather than substitutive.

This interpretation also emphasizes the fundamentally irreversible nature of cosmic evolution. As the Universe evolves, primordial conditions become progressively inaccessible and increasingly difficult to reproduce experimentally. Absolute zero remains only an asymptotic limit, just as extinct biological forms cannot be fully regenerated despite the persistence of partial traces of their existence. In this sense, thermodynamic evolution reflects the same directional and historical character observed throughout the other components of the Universe analyzed in this work.

3.7.a - Thermodynamic Lineages

Figure 10 correlates several thermodynamic properties of atoms ordered by increasing atomic number: melting point, boiling point, the temperature interval between the two transition states, and ionization energy. As in the previous atomic graphs, recurrent periodic behavior is observed, with greater variability in the middle of the atomic lineages and greater stability near the noble gases.

Noble gases show very close melting and boiling points, indicating highly stable thermodynamic configurations.

A progressive increase of these transition temperatures is observed along the noble gas sequence:

* He: 1–4 K
* Ne: 25–27 K
* Ar: 84–87 K
* Kr: 116–120 K
* Xe: 161–165 K
* Rn: 202–211 K

The temperature difference between boiling and melting points remains small and relatively regular: about 3 K for He and Ne; about 4 K for Ar, Kr, and Xe; about 9 K for Rn.

Melting points show a relatively uniform distribution among the various atomic lineages, whereas boiling points become less regular in the heaviest lineage.

The delta between boiling and melting temperatures shows a generally homogeneous distribution, with a slight tendency to increase with atomic number.

Arsenic is the only significant anomaly, showing a negative apparent delta value because it sublimates directly from solid to gas under normal atmospheric pressure. Liquid arsenic forms only above approximately 28 atm.

Ionization energy also exhibits periodic behaviour: early atomic lineages show large variations; heavier and more "evolved" lineages show progressively lower and more homogeneous ionization energies. Since ionization energy measures the energy required to remove an electron from an atom, higher values correspond to greater electronic stability. The most abundant and lighter atoms therefore appear thermodynamically more stable, whereas heavier atoms are generally more reactive and more easily ionized. This increasing reactivity may favour chemical interactions and the formation of increasingly complex compounds, similarly to the increase of variability observed in evolutionary biological systems.

The thermodynamic distributions suggest a transition from highly stable and simple atomic configurations toward progressively more reactive and variable systems. The periodic recurrence associated with noble gases indicates that atomic evolution follows stable intermediate configurations separated by phases of increasing variability.

The data may also suggest that the primordial Universe was characterized by extremely low-energy and low-complexity conditions. Near absolute zero, atomic motion becomes minimal and matter approaches highly ordered states. Under such conditions, hydrogen becomes solid and helium remains liquid.

According to this interpretation, the evolution of matter corresponds to a progressive increase in energy, interaction, and complexity over time. The current Universe appears far more thermodynamically active and structurally differentiated than its primordial state. This interpretation differs from the standard big-bang picture of an initially extremely hot and energetic Universe. If the Universe originated from a primordial high-energy state, its thermodynamic evolution would correspond to progressive cooling toward lower-energy conditions. Instead, the present analysis suggests the opposite trend: absolute zero remains extremely difficult to achieve experimentally, whereas arbitrarily high temperatures can be generated without clear theoretical limits. This may indicate a long-term evolution away from thermodynamic stasis and toward increasing energetic complexity. Within this

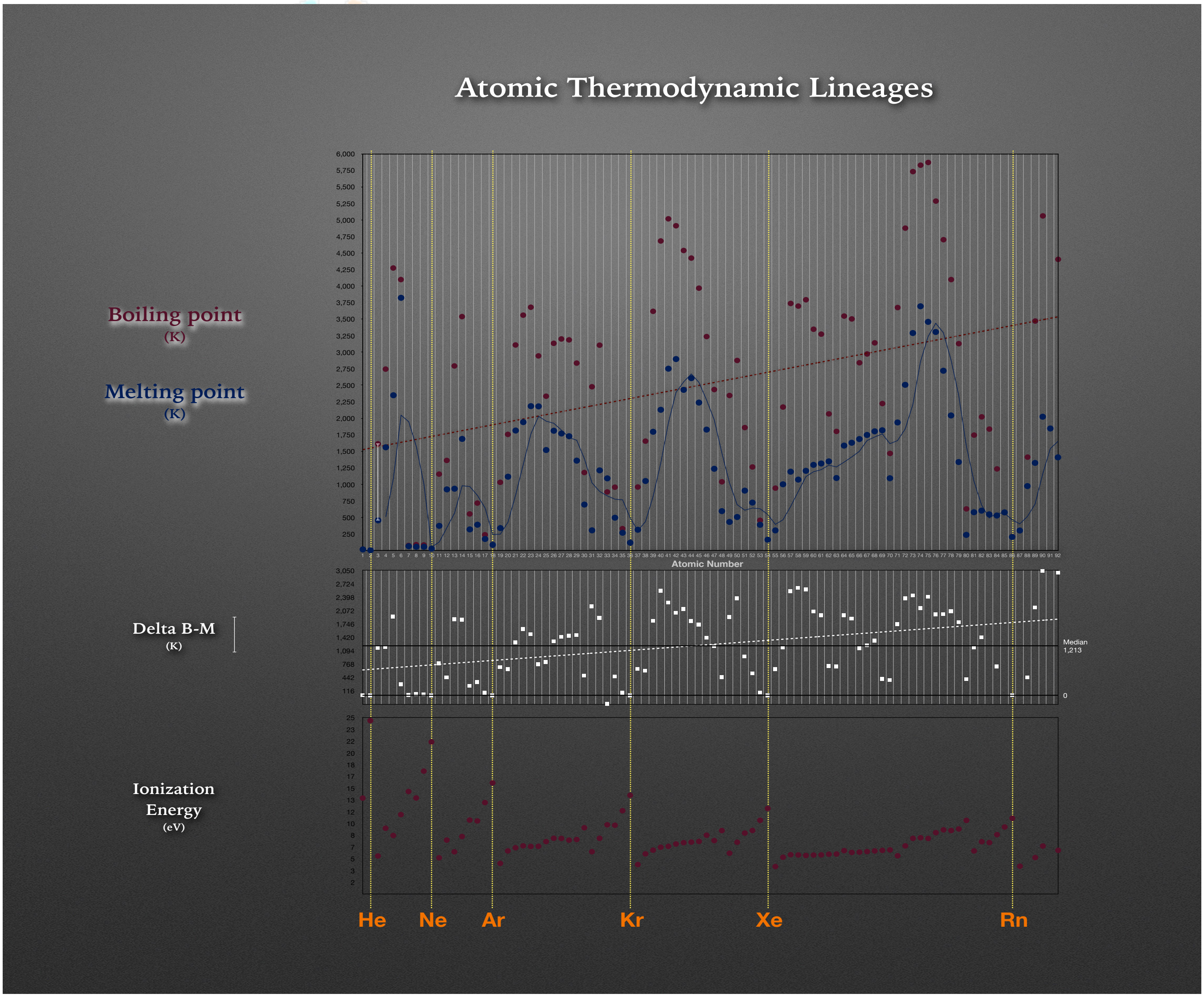

Figure 10: Atomic Thermodynamic Lineages.
Top graph: Melting (blue dots) and boiling (red dots) points of atoms sorted by increasing atomic number. Melting point graph shows a trend line (moving average, period 4, continuous thin blue line). Boiling point graph shows a linear trend line (dotted red).
Middle graph: Graph of the difference between the melting and boiling point of various atoms, with two reference lines (the zero Kelvin and the median of the difference, continuous black lines) and a linear trend line (dotted white).
Bottom graph: Ionization energy expressed in eV. The noble gases are highlighted as in Figure 2.
Trend lines are purely visual aids and do not imply deterministic evolutionary trajectories.

framework, the growth of temperature, reactivity, and structural variability would represent a progressive thermodynamic evolution accompanying the simultaneous development of mass, spacetime, and motion in a system that starts cold and gradually heats up.

3.8 - Summary table of Evolutionary Rules Applied to Physical Systems

The comparative analysis of physical components of the Universe shows recurrent patterns compatible with several characteristics of Darwinian evolutionary systems. Across all physical scales, similar trends emerge: increasing complexity, stability of simpler forms, selection of stable configurations, elimination of unstable states, and progressive structural integration. Although these processes are not biological, they may represent analogous forms of evolutionary selection acting within an expanding spacetime framework. Table 2 illustrates a hypothetical application of evolutionary principles to the physical components of the Universe.

Table 2: Comparative organizational properties observed across multiple physical domains. The table summarizes heuristic analogies concerning persistence, differentiation, hierarchical integration, and irreversible transformation within physical systems. These principles are intended as conceptual organizational tendencies rather than strict universal laws or literal extensions of evolutionary rules (defined in paragraph 2.1).

	Variation	**Heritability**	**Persistence**
Elementary Particles	Numerous particle types and unstable states emerge under high-energy conditions	Stable particles become conserved building blocks of all higher physical structures	Stable particles (electrons, protons) persist, while unstable particles decay rapidly
Atoms	Different atomic and isotopic configurations emerge through nucleosynthesis	Complex atoms preserve elementary particles and previous nuclear structures	Stable atoms persist over cosmological timescales, whereas radioactive isotopes decay (Valley of Stability)
Stars and Stellar Systems	Stars differ in mass, luminosity, metallicity, and lifetime	Stellar evolution conserves and redistributes previously generated elements into new stars and planets	Stable stellar configurations survive longer; unstable stars collapse or explode (Hertzsprung-Russell diagram)
Motion	Multiple dynamical regimes emerge: oscillation, waves, rotation, orbital motion	Rotational dynamics are conserved across scales, from particle spin to galaxies	Stable rotational and orbital motions persist preferentially over chaotic trajectories
Time	Different temporal scales emerge through motion, gravity, and relativistic conditions	Temporal sequences are conserved through repetitive physical processes across cosmic evolution	Stable repetitive temporal cycles persist and become measurable references
Fundamental Forces	Different interaction regimes emerge as spacetime and matter develop	Earlier force regimes remain embedded within later physical structures	Stable interaction configurations persist across cosmic scales
Thermodynamic Systems	Different energetic and entropic states emerge with increasing complexity	Earlier thermodynamic regimes remain preserved within later cosmic structures and processes	Stable equilibrium states persist longer than highly unstable energetic states

4. PERSPECTIVE

The present work proposes that evolutionary dynamics analogous to Darwinian natural selection may extend beyond biology and operate throughout the physical Universe. Since biological systems are themselves composed of the same elementary constituents governed by physical laws, it is reasonable to explore whether the mechanisms underlying biological evolution — variation, stability, selection, persistence, and elimination — may also characterize the evolution of matter, spacetime, motion, and physical interactions that precede the biological realm.

The analyses presented here suggest the existence of recurrent evolutionary patterns across multiple physical scales. Elementary particles, atoms, stars, thermodynamic systems, and large-scale cosmic structures all appear to exhibit common trends: stable configurations persist over long timescales, unstable forms decay or disappear, complexity increases progressively, and new structures emerge through the integration of pre-existing systems. These behaviors are compatible with an evolutionary process governed by the interaction between structural variability and environmental constraints.

This hypothesis differs substantially from cosmological natural selection models proposed by Smolin (1997), where evolution occurs through successive generations of universes originating from black holes. In the framework proposed here, evolution acts directly within a single Universe through the progressive co-development of mass, spacetime, motion, thermodynamics, and physical laws themselves. The Universe is therefore interpreted not as a static system governed by immutable laws established instantaneously at its origin, but as a continuously evolving physical structure whose interactions and governing regimes emerged progressively over cosmic history.

A particularly original aspect of this hypothesis is the proposal that the fundamental forces and physical laws may themselves represent evolutionary products. Quantum interactions, gravitation, thermodynamic laws, and spacetime geometry could correspond to different organizational stages of the same evolving system, preserved simultaneously as increasingly complex physical regimes emerged. In this perspective, the apparent separation between quantum mechanics and relativistic physics may reflect the observation of different evolutionary scales rather than fundamentally incompatible descriptions of reality.

Within this broader conceptual framework, several possible cosmological consequences emerge. One speculative implication concerns the thermodynamic history of the Universe. If matter, spacetime, and energy were generated progressively rather than instantaneously, the large-scale thermal evolution of the Universe may not correspond exclusively to the cooling of an initially ultra-energetic state, but potentially also to a gradual and localized warming process associated with cumulative stellar, atomic, and interaction-driven energy production (McKellar, 1941; Penzias, 1965; Dicke, 1965). In such a scenario, the cosmic microwave background could be interpreted not solely as residual radiation from a primordial explosion, but also as the diffuse thermodynamic signature of long-term evolutionary physical processes distributed throughout cosmic history. This interpretation remains highly speculative and does not presently replace the standard cosmological description, but it illustrates how the proposed evolutionary framework may suggest alternative interpretations of large-scale thermodynamic observations.

A second possible implication concerns the age and temporal development of the Universe itself. Recent observations obtained with the James Webb Space Telescope, including the detection of unexpectedly evolved galaxies at very high redshifts, have intensified discussions regarding the so-called “impossible early galaxy” problem (Gupta, 2023; Greene, 2024; Labbé, 2023; Boylan-Kolchin, 2023). Within the evolutionary framework proposed here, such observations may be more naturally compatible with a Universe evolving gradually through cumulative and overlapping processes extending over substantially longer timescales than currently estimated. Stellar evolution, galactic formation, black-hole growth, and biological evolution all proceed through slow and progressive transformations rather than instantaneous transitions. The coexistence of stellar and galactic populations at very different evolutionary stages may therefore resemble biological ecosystems, where structures of different ages persist simultaneously within the same environment. Although no mathematical formalism currently supports this interpretation, the hypothesis suggests that cosmic evolution may involve asynchronous and partially localized developmental processes rather than a single fully synchronized primordial event.

A third conceptual consequence concerns the interpretation of cosmic expansion. Within the present framework, expansion may be viewed not simply as the inertial aftermath of an initial explosion, but as the ongoing co-development of matter and spacetime through incremental creation and progressive separation. Newly generated matter would continuously disperse within simultaneously emerging spacetime, while the enlargement of spacetime itself would permit further differentiation, interaction, and structural complexity. In this interpretation, spacetime and mass are not independent entities but mutually connected components of the same evolving relativistic system. Such a perspective may offer a conceptual explanation for the hierarchical and non-uniform large-scale organization of the observable Universe, including the cosmic web and the coexistence of overlapping evolutionary structures (Cautun, 2014; Jones, 2014).

The observed large-scale structure of the Universe, including the cosmic web (Cautun, 2014; Jones, 2014), appears highly non-uniform and hierarchically organized, more consistent with gradual and localized development processes than with perfectly homogeneous evolution. Recent observational tensions involving early galaxy formation detected by the James Webb Space Telescope, together with the absence of definitive experimental evidence for several dominant theoretical frameworks, encourage consideration of alternative cosmological interpretations (Labbé, 2023; Boylan-Kolchin, 2023; Robertson, 2024).

Within this context, the evolutionary framework proposed here attempts to provide a unifying conceptual approach linking particle physics, stellar evolution, thermodynamics, and cosmology through common dynamical principles. The extraordinary stability of some elementary particles, such as the electron — whose predicted lifetime (6.6×10^{28} years) vastly exceeds the currently estimated age of the Universe — may suggest that certain physical structures behave effectively as persistent evolutionary states rather than transient products of a singular primordial event.

The hypothesis remains highly speculative and presently lacks a formal mathematical formulation capable of generating quantitative predictions. The proposed interpretations should therefore be considered conceptual and heuristic rather than demonstrative physical models. Nevertheless, recent experimental results showing photon–photon matter production and interaction-driven mass emergence indicate that some aspects of matter formation may already be compatible with dynamic and evolutionary interpretations of physical reality (Aaboud, 2017; Adam, 2021; Ding, 2022).

The potential relevance of this hypothesis lies precisely in proposing a common evolutionary language applicable across traditionally separated scientific domains. By treating matter, motion, spacetime, thermodynamic laws, and physical interactions as components of a single evolving system, this framework may offer new conceptual directions toward a broader unification of modern physics.

At the same time, the vastness and complexity of the concept of “Universe” — encompassing all observable and potentially non-observable physical reality — necessarily require a deeply integrated multidisciplinary approach. The questions raised by this work extend beyond cosmology alone and involve particle physics, thermodynamics, relativity, quantum theory, complexity science, systems biology, philosophy of science, and the study of emergent phenomena.

It seems logical to assume that a system composed of the same basic elements, combined in different ways, would follow the same rules rather than two or more different patterns of development.

For these reasons, the present work should be considered as an open theoretical perspective intended primarily to stimulate interdisciplinary discussion among physicists, cosmologists, mathematicians, complexity theorists, evolutionary biologists, and philosophers of science. Even if some aspects of the hypothesis ultimately prove incomplete or incorrect, the attempt to explore common organizational principles linking matter, life, spacetime, and physical laws may still contribute to the broader scientific effort toward understanding the evolutionary structure of the Universe as a whole.

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