Part A5 - **The Formation of Matter**

An Alternative to the Big Bang

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Abstract

This article introduces an alternative cosmological framework in which space and time exist independently of matter and its evolution. The framework is founded on five physical axioms defining space, time, the energy dimension of space, energy-related forces, and the zero total energy of the universe.

The central principle is that zero net energy does not imply the absence of physical structure. Autonomous positive and negative energy components can form different configurations while maintaining a zero-energy balance. This property provides the foundation for the spontaneous formation of microscopic electromagnetic toruses in neutral equilibrium.

Interactions between these micro-toruses initiate a process of energy organization. Their merging increases both positive internal energy and the magnitude of negative binding energy, while the resulting energy difference is released as electromagnetic radiation. Through successive interactions, geometrical and resonant saturation leads to persistent toroidal configurations, identified in the proposed model with electrons and positrons.

Matter formation is thus described as a continuing process of energy differentiation, organization, and stabilization rather than a unique primordial event. Material structures may subsequently develop, transform, or disappear without changing the total energy of the universe.

The framework establishes a unified conceptual foundation for describing the evolution of matter from the first stable particles to the present universe, without requiring the creation of space, time, or net energy.

1. Introduction

The origin of the universe and the formation of matter are among the most fundamental questions in physics. The prevailing cosmological model describes the evolution of the observable universe from an extremely hot and dense early state. Its success in explaining cosmic expansion, primordial element abundances, and the cosmic microwave background is well established. Nevertheless, the physical origin of space, time, and matter remains an open subject of investigation.

This article proposes a different conceptual starting point. Rather than assuming that space and time originated in a primordial event, it treats them as fundamental properties of physical reality, independent of the existence of matter. The central question is therefore not when space and time began, but how matter can emerge and develop within an already existing universe.

The proposed framework is based on five physical axioms defining the existence of space, the independence of time, the energy dimension of space, the relationship between energy and forces, and the zero-energy balance of the universe.

A central concept is that every point of space possesses an energy degree of freedom. This property allows different physical energy configurations to exist at the same spatial location. Importantly, different configurations may have the same net energy, including zero. Consequently, an energetically neutral state need not correspond to a unique or physically inactive configuration.

The model further postulates that the total energy of the universe is zero. Positive energy associated with matter and electromagnetic radiation is balanced by negative binding energy. Physical evolution therefore does not require an increase in the total energy of the universe. Instead, it involves the redistribution and structural organization of positive and negative energy components.

Within this framework, an energetically empty region of space may spontaneously develop microscopic electromagnetic structures with zero net energy. The proposed elementary configuration is a micro-torus, in which positive energy and negative binding energy are balanced. Such a structure may remain in neutral equilibrium without a necessary tendency either to grow or to disappear.

When two compatible micro-toruses interact, their electromagnetic fields may reorganize into a larger structure. The resulting configuration can possess greater positive internal energy and an even greater magnitude of negative binding energy. The difference is released as electromagnetic radiation, while the total energy balance remains unchanged.

Repeated interactions may lead to increasingly organized toroidal structures. Their growth is not necessarily unlimited or continuous. Geometrical constraints and resonant conditions can produce local energy minima, allowing persistent configurations to emerge. Within the proposed model, electrons and positrons are considered examples of such stable toroidal structures.

This provides a hypothetical pathway from energetically neutral space to persistent matter without requiring the simultaneous creation of space, time, and energy. The further organization of these structures into more complex particles is beyond the scope of the present article.

The purpose of this study is to establish the fundamental axioms and outline the physical mechanisms through which matter might arise from energy organization in an existing universe. The article does not attempt to reconstruct the earliest history of the universe or provide a complete alternative explanation for all cosmological observations. Instead, it examines whether a zero-energy framework, combined with electromagnetic field dynamics and toroidal stability, can provide a coherent foundation for a continuous process of matter formation.

The proposed mechanisms are hypotheses requiring further mathematical development and experimental verification. In particular, the origin and dynamics of negative binding energy, the spontaneous formation of micro-toruses, and the correspondence between stable toroidal configurations and observed particles remain to be established. [5, 6]

2. Fundamental Physical Axioms

The proposed model is founded on five physical axioms defining the fundamental properties of space, time, energy, and their interactions. These axioms are introduced as the conceptual basis of the model rather than derived conclusions. Their purpose is to establish a framework in which matter can develop without requiring the creation of space and time.

2.1. Axiom 1 — Existence of Space

Space exists independently of matter and the energy structures contained within it.

Space possesses three spatial dimensions, represented by the coordinates

$$(x, y, z).$$

Its existence does not depend on the presence of particles, electromagnetic radiation, or other physical structures. Space is therefore regarded as a fundamental constituent of physical reality rather than a consequence of matter or a particular cosmological event.

2.2. Axiom 2 — Existence of Time

Time exists independently of matter, motion, and physical processes.

Time provides the fundamental dimension along which physical states and events can be ordered. Its existence does not depend on the operation of clocks or on changes occurring within matter.

In this framework, space and time are not created by a physical event. They provide the continuous foundation within which the evolution of energy and matter takes place.

2.3. Axiom 3 — Energy Dimension of Space

Every point of space possesses an energy degree of freedom that permits different physical energy states, including configurations with zero net energy.

A physical point is described by

$$P = (x, y, z, t, e)$$

where x, y, z denote spatial coordinates, t denotes time, and e represents the local energy state.

The local energy state e consists of two autonomous components, e_p and e_v, representing positive energy and negative binding energy, respectively. These components can assume different numerical values independently of one another, while their combined contribution determines the local net energy.

Consequently, zero net energy does not uniquely define the physical state of space. Different combinations of positive and negative energy may satisfy $e_p + e_v = 0$, including the state in which both components vanish. The energy dimension therefore permits multiple physically distinct configurations with the same zero-energy balance.

The energy dimension is not an additional spatial direction. It represents an intrinsic degree of freedom through which space can support different energy configurations.

At each point of space, positive energy W_p and negative binding energy W_v may assume independent numerical values, as they represent autonomous energy components. Their magnitudes are not individually determined by the net energy of the point. Different combinations of W_p and W_v may

therefore represent distinct physical energy states.

Consequently, zero net energy does not uniquely determine the physical state of space. Positive and negative energy components may coexist in different magnitudes while satisfying $W_p + W_v = 0$. Thus, energetically neutral space can possess different internal energy configurations, including the absence of both components.

2.4. Axiom 4 — Energy as the Origin of Force

Energy differences generate forces that govern the motion and reorganization of energy fields and material structures.

These forces may redistribute energy among different forms without changing its total amount. When energy can be emitted, they may enable transitions toward lower internal energy states.

Forces are therefore associated with the spatial configuration and distribution of energy.

A physical structure may remain in equilibrium while its internal energy continuously changes between different forms. Such internal dynamics do not necessarily require energy emission.

When interactions permit the release of energy, a structure may undergo reorganization toward a lower accessible internal energy state. Local energy minima, determined by geometrical and dynamical constraints, may support persistent structures.

2.5. Axiom 5 — Zero Total Energy of the Universe

The total energy of the universe is zero and remains unchanged. Energy may be redistributed among different forms, but its global sum is conserved.

Mathematically,

$$\boxed{W_{\text{universe}} = 0}$$

and

$$\boxed{\frac{dW_{\text{universe}}}{dt} = 0}.$$

The model distinguishes positive and negative energy contributions. Positive energy may be associated with the internal dynamics of matter and electromagnetic radiation, while negative energy is associated with binding.

In the proposed energy representation,

$$\boxed{W_p + W_v + W_s = 0}$$

where W_p is the total positive energy associated with the internal motion of material structures, W_v is their negative binding energy, and W_s is the positive energy of electromagnetic radiation.

These quantities represent global energy contributions, not necessarily the energy balance of an individual particle.

Thus, the growth of matter and the emission of radiation can occur without changing the total energy of the universe, provided that the corresponding negative binding energy changes consistently with the global balance.

2.6. Combined Physical Meaning of the Axioms

The first three axioms establish space, time, and the energy degree of freedom as fundamental properties of physical reality. The fourth axiom introduces the forces responsible for physical interactions and energy reorganization. The fifth axiom constrains these processes through the conservation of a zero global energy balance.

Together, the axioms provide the conceptual basis for investigating whether energetically neutral space can support spontaneously formed structures and whether their subsequent interactions can lead to persistent matter.

The following sections examine the proposed mechanisms of energy-state differentiation,

micro-torus formation, torus merging, and the emergence of stable material particles.

3. Energy States of Empty Space

3.1. Empty Space and the Energy Degree of Freedom

According to the proposed axioms, space exists independently of matter and possesses an intrinsic energy degree of freedom. Consequently, the absence of matter and electromagnetic radiation does not imply the absence of possible energy states.

In a completely empty region of space, both positive energy W_p and negative binding energy W_v may initially be zero:

$$W_p = 0, \qquad W_v = 0.$$

However, this configuration does not exhaust the possible states of the energy dimension. The energy degree of freedom allows positive and negative energy components to acquire nonzero values without necessarily changing their combined energy.

Thus, empty space is not regarded as a physical system restricted to a single energy configuration. It possesses the capacity to support different internal energy states.

3.2. Autonomy of Positive and Negative Energy

The model distinguishes two autonomous energy components: positive energy W_p and negative binding energy W_v.

These components may assume different numerical magnitudes while remaining subject to the overall energy balance. In particular, they may satisfy

$$\boxed{W_p + W_v = 0}$$

even when neither component is zero.

For example, the configurations

$$(W_p, W_v) = (0,0),$$

$$(W_p, W_v) = (W, -W),$$

and

$$(W_p, W_v) = (2W, -2W)$$

all possess the same net energy.

They nevertheless represent different internal energy states.

The energy dimension of space therefore permits a distinction between net energy and internal energy organization. A zero-energy state may contain nonzero positive and negative energy components whose contributions cancel.

3.3. Neutral Equilibrium of Energy States

When positive and negative energy components are balanced, the resulting configuration may occupy a state of neutral equilibrium.

In the proposed model, neutral equilibrium means that the configuration has no inherent energetic preference either to maintain its particular organization or to transform into another energetically equivalent state.

Such a state may persist indefinitely in the absence of interactions or disturbances. Its continued existence does not require continuous energy input, nor does the equality of its positive and negative energy components necessarily force their mutual disappearance.

Neutral equilibrium therefore does not imply continuous fluctuations. It permits persistent configurations as well as possible transitions between energetically equivalent states.

The actual occurrence of a transition depends on the dynamics and interactions of the energy fields.

3.4. Spontaneous Differentiation of the Zero-Energy State

An important consequence of the proposed energy dimension is the possibility of

spontaneous differentiation of an initially unstructured zero-energy state.

A local energy configuration may develop positive and negative components simultaneously:

$$0 \longrightarrow (+W) + (-W).$$

The total energy remains unchanged:

$$\Delta W_p + \Delta W_v = 0.$$

This process does not represent the creation of net energy. Instead, it represents the formation of an internally differentiated energy configuration from an initially undifferentiated state.

The model postulates that such transitions are physically possible because the energy dimension permits multiple energetically equivalent configurations.

However, the existence of multiple equivalent states does not make transitions between them inevitable. A particular neutral state may persist indefinitely. Spontaneous differentiation is therefore considered an allowed process rather than a continuously required transformation.

3.5. From Energy Differentiation to Physical Structures

The appearance of positive and negative energy components introduces the possibility of electromagnetic field organization.

Within the proposed framework, the physical behavior of electric and magnetic fields follows Maxwell's equations. These equations permit different electromagnetic configurations, including propagating waves and fields with toroidal topology.

The model distinguishes between electromagnetic radiation, which transports positive energy, and localized configurations in which positive energy is balanced by negative binding energy.

The latter are proposed as candidates for the earliest microscopic energy structures.

Because such configurations may have zero net energy, their formation is compatible with the assumed zero-energy balance of the universe.

The simplest proposed localized structure is a micro-torus. Its emergence, internal field organization, and subsequent development are addressed in the following section.

3.6. Physical Significance

The central implication of this chapter is that zero energy and the absence of physical structure are not equivalent concepts.

Space may possess zero net energy while supporting nonzero, mutually compensating energy components. These configurations may persist without energy exchange or undergo transformations when suitable conditions arise.

In this interpretation, the energy dimension of space provides the possibility of forming physical structures without requiring the creation of additional net energy.

The transition from an unstructured energy state to a localized configuration is therefore regarded as a process of energy differentiation and organization rather than the creation of energy from nothing.

4. Spontaneous Formation of Micro-Toruses

4.1. Electromagnetic Laws of the Energy Dimension

According to the third axiom, space possesses an intrinsic energy degree of freedom, allowing positive and negative energy components to form different physical configurations. The proposed model associates the dynamics of these configurations with electromagnetic fields governed by Maxwell's equations.

Maxwell's equations describe the coupled behavior of electric and magnetic fields, permitting both freely propagating electromagnetic waves and configurations with toroidal field topology.

Of particular importance is the absence of magnetic monopoles, expressed by

$$\nabla \cdot B = 0$$

Magnetic field lines have no isolated beginnings or ends. Together with electromagnetic induction, this property permits organized field configurations in which electric and magnetic fields form interconnected structures.

The proposed model introduces an additional energy property: the distinction between positive energy W_p and negative binding energy W_v. While Maxwell's equations govern the electromagnetic field dynamics, the balance between these two energy components provides an additional condition for the formation of energetically neutral structures.

For an elementary micro-torus, this balance is expressed as

$$W_p + W_v = 0$$

The model therefore identifies the micro-torus as a possible elementary configuration in which electromagnetic field organization and zero net energy coexist.

Unlike freely propagating electromagnetic radiation, which carries positive energy, the proposed micro-torus possesses compensating positive and negative energy contributions.

Its formation is thus compatible with the zero-energy axiom of the universe.

The toroidal configuration is consequently considered a candidate for the spontaneous formation of localized energy structures without requiring the creation of additional net energy. [1, 2, 3, 4]

4.2. Spontaneous Emergence from an Energetically Neutral State

As discussed in Section 3, zero net energy does not uniquely determine the physical state of space. Different configurations of positive and negative energy may coexist with the same zero-energy balance.

An initially unstructured region of space is characterized by

$$W_p = 0, \qquad W_v = 0.$$

The energy degree of freedom permits a transition to a differentiated state:

$$0 \longrightarrow W_p + W_v,$$

where

$$W_p > 0, \qquad W_v < 0.$$

For an energetically neutral micro-torus,

$$\boxed{W_p + W_v = 0}.$$

The transition therefore does not require an increase in the total energy of the universe.

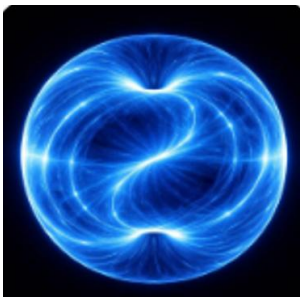


Figure 1. Spontaneous energy organization. Conceptual illustration of a localized electromagnetic structure emerging from an energetically neutral state of space. Positive energy W_p and negative binding energy W_v form an organized configuration while maintaining zero net energy.

The model postulates that such a transition may occur spontaneously, without a pre-existing material particle or an external energy source. It is not assumed that every neutral state must undergo this transition. An undifferentiated state may persist indefinitely,

while other regions may develop localized energy configurations.

Spontaneous formation is thus regarded as a possibility arising from the energy degree of freedom rather than as an inevitable continuous process.

4.3. Toroidal Organization of the Fields

The proposed micro-torus consists of a localized electromagnetic field configuration in which the internal fields are organized around a closed toroidal geometry.

The major radius R describes the overall size of the torus, while the minor radius a characterizes its cross-sectional structure.

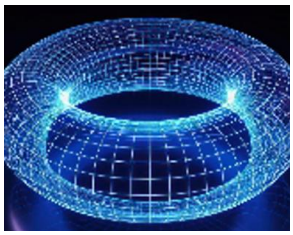


Figure 2. Toroidal field configuration. Conceptual representation of a micro-torus with major radius (R) and minor radius (a). The closed geometry supports the proposed internal organization of electromagnetic fields and the balance between positive energy W_p and negative binding energy W_v.

Within this geometry, electric and magnetic fields are coupled through their time-dependent behavior. Their spatial organization permits internal energy exchange without necessarily requiring the propagation of the entire structure through space.

The proposed toroidal arrangement incorporates positive energy associated with internal field dynamics and negative energy associated with binding.

Maxwell's equations describe the electromagnetic fields and their associated energy density, which is non-negative. The proposed model introduces an additional distinction between two forms of energy: positive energy W_p and negative binding energy W_v. The negative sign does not imply a negative quantity of field content in space; it characterizes the binding contribution of energy to the structure and its energy balance. Thus, the model retains the conventional electromagnetic field description while introducing an additional attribute of energy associated with the formation and stability of toroidal structures.

The detailed field distributions, internal dynamics, and resonance conditions are developed in the accompanying studies of toroidal energy structures. The present article focuses on their role in the proposed formation of matter.

4.4. Neutral Equilibrium of an Isolated Micro-Torus

The newly formed micro-torus is assumed to possess equal magnitudes of positive and negative energy:

$$\boxed{W_p = |W_v|}.$$

Its total internal energy is therefore zero.

The two energy components produce opposing structural tendencies. Positive energy tends to destabilize or expand the configuration, while negative binding energy tends to maintain and strengthen its internal organization.

In the proposed neutral equilibrium, these tendencies balance one another.

Consequently, an isolated micro-torus has no necessary energetic tendency either to disappear or to develop into a larger structure.

It may persist without continuous energy input or energy emission.

This equilibrium does not imply that the internal electromagnetic fields are static. Energy may be redistributed among the internal degrees of freedom while the overall configuration remains unchanged.

Neutral equilibrium is therefore compatible with continuous internal field dynamics.

Energy balance and force equilibrium represent two distinct conditions. The equality of positive and negative energy magnitudes ensures zero net energy but does not, by itself, establish mechanical equilibrium. The micro-torus is assumed to satisfy both conditions: its energy components cancel in the total energy balance, while their associated structural forces are balanced. Neutral stability further requires that small perturbations do not generate a systematic tendency toward either restoration or disruption of the structure.

4.5. Interaction Between Micro-Toruses

The neutral equilibrium of an isolated micro-torus does not necessarily persist when another micro-torus approaches.

As their electromagnetic fields begin to overlap, the energy distribution of the combined system changes. Their mutual interaction may introduce forces that alter the original configurations.

Depending on their relative geometry, orientation, and phase relationships, the interaction may result in deformation, separation, radiation, or merging.

When the field configurations are sufficiently compatible, a combined toroidal structure may become energetically favorable.

In such a process, the magnitude of negative binding energy may increase more than the positive internal energy. The difference can be released as electromagnetic radiation.

The resulting torus may therefore possess a lower internal energy and greater structural stability than the initially separate micro-toruses.

This interaction introduces a mechanism through which initially neutral microscopic structures may evolve into larger and more strongly bound energy configurations.

4.6. Significance for the Formation of Matter

The spontaneous emergence of micro-toruses represents the first proposed stage in the organization of energy into localized physical structures.

Unlike the formation of a freely propagating electromagnetic wave, the formation of an energetically neutral micro-torus is assumed to involve no net increase in energy.

An isolated micro-torus may remain in neutral equilibrium, while interactions with other micro-toruses can initiate structural growth.

Thus, the model distinguishes between two fundamental processes: the spontaneous appearance of neutral microscopic structures and their subsequent energy-driven reorganization.

Repeated interactions and energy emission may lead to configurations with increasingly strong binding and greater stability.

The following section examines this process of torus growth and merging as the proposed pathway toward persistent material particles.

5. Growth and Merging of Toruses

5.1. From Neutral Micro-Toruses to Interacting Structures

An isolated micro-torus may remain in neutral equilibrium, with its positive energy W_p balanced by negative binding energy W_v. Its internal dynamics do not necessarily cause growth, decay, or radiation.

The situation changes when two micro-toruses approach one another. Their electromagnetic fields begin to interact, modifying the energy distribution and the forces acting within the combined system.

According to the fourth axiom, energy differences generate forces that govern the

motion and reorganization of energy structures. These forces may redistribute energy between different forms and enable transitions toward lower internal energy states.

Depending on the relative geometry, orientation, and phase of the interacting toruses, their encounter may result in deformation, separation, radiation, or merging.

Merging becomes possible when their electromagnetic configurations are sufficiently compatible to form a common toroidal structure.

5.2. Energy Redistribution During Merging

When two micro-toruses merge, the resulting torus is not merely the geometrical sum of the original structures. Their electromagnetic fields reorganize, producing a new distribution of positive and negative energy.

The proposed model assumes that merging can increase both the positive internal energy W_p and the absolute magnitude of negative binding energy $|W_v|$.

For an energetically favorable merging event, the increase in binding-energy magnitude exceeds the increase in positive internal energy. The resulting decrease in the combined internal energy is released as electromagnetic radiation.

Energy conservation requires

$$\boxed{\Delta W_p + \Delta W_v + W_s = 0}$$

where ΔW_p and ΔW_v represent changes relative to the combined initial toruses, and W_s is the energy emitted during the interaction.

For a merging process in which $\Delta W_p > 0$, $\Delta W_v < 0$, and $W_s > 0$, this becomes

$$\boxed{|\Delta W_v| = \Delta W_p + W_s}.$$

Thus, a larger and more strongly bound torus may emerge while the total energy of the complete system remains unchanged.

5.3. Radiation as a Mechanism of Stabilization

Electromagnetic radiation plays a fundamental role in the proposed growth mechanism.

During merging, the internal electromagnetic fields must adapt to a new geometry and energy distribution. This reorganization may involve transient oscillations and changes in the direction and magnitude of energy flow.

These transient processes can generate electromagnetic radiation, allowing the combined structure to release energy that is no longer retained in its final internal configuration.

Radiation therefore provides a mechanism through which the new torus may approach a lower internal energy state.

Importantly, continuous radiation is not required once the torus reaches a stable configuration. Its internal fields may continue to exchange energy without producing a net outward energy flux.

The model thus distinguishes between radiation associated with structural transitions and the persistent internal dynamics of a stable torus.

5.4. Increasing Binding and Structural Stability

Successive merging events may produce toruses with increasing positive internal energy and increasingly negative binding energy.

The magnitude of the negative binding energy can grow more rapidly than the positive energy, resulting in a progressively lower net internal energy.

In the proposed model, stronger binding generally favors the persistence of the structure, provided that the geometry and internal field dynamics remain compatible with a stable configuration.

However, energetic binding and dynamical stability are distinct properties. A favorable energy balance alone does not guarantee that a torus is stable against deformation.

The resulting structure must also satisfy the conditions of force equilibrium and an appropriate response to perturbations.

Thus, the development of stable toruses involves both energy redistribution and the establishment of favorable geometrical and dynamical conditions.

5.5. Growth Is Not Necessarily Continuous

Torus growth is not assumed to proceed without interruption.

As a torus increases in energy, its major radius R, minor radius a, and internal resonant configuration may change. These changes can introduce geometrical constraints and resonant saturation.

At certain configurations, the torus may reach a local energy minimum in which further growth through the existing merging mechanism becomes energetically unfavorable.

Such a configuration may remain stable even if larger or more strongly bound structures are physically possible.

A transition beyond this state may require different interaction conditions, additional energy, or a substantial reorganization of the internal fields.

Consequently, the proposed development of toroidal structures may involve a sequence of stable configurations rather than uninterrupted growth toward a single final state.

5.6. Toward Persistent Material Particles

The combination of merging, increasing binding energy, radiation, and geometrical saturation provides a proposed pathway from neutral micro-toruses to persistent energy structures.

Initially, microscopic toruses may exist in neutral equilibrium. Their interactions permit growth and energy redistribution. Successive reorganizations may lead to stronger binding and increasingly constrained internal field configurations.

When geometrical and resonant saturation establishes a stable local energy minimum, further spontaneous reorganization through the same mechanism may become strongly suppressed.

Within the proposed model, electrons and positrons are examples of such stable toroidal configurations.

Their formation represents a transition from elementary energy organization to persistent material particles.

The following section examines this transition and the role of geometrical and resonant saturation in the proposed formation of stable matter.

6. Formation of Stable Matter

6.1. From Growing Toruses to Stable Structures

The merging of micro-toruses provides a proposed mechanism through which initially neutral energy configurations develop into larger and more strongly bound structures. However, this growth does not necessarily continue without limitation.

As a torus accumulates energy, its geometry and internal electromagnetic dynamics change. The major radius R, minor radius a, and resonant field configuration must continuously adapt to the evolving energy distribution.

At certain stages, the internal organization may reach conditions under which further growth through the existing mechanism becomes energetically unfavorable.

Such configurations can represent local energy minima, allowing persistent toroidal structures to emerge.

In the proposed model, the formation of stable matter is therefore associated with the

appearance of geometrically and dynamically constrained energy configurations rather than with an arbitrary threshold of accumulated energy.

6.2. Geometrical and Resonant Saturation

Two closely related mechanisms are proposed to govern the stabilization of toroidal structures.

Geometrical saturation occurs when the relationship between the major radius R and minor radius a approaches a configuration in which further deformation or expansion becomes energetically unfavorable.

Resonant saturation occurs when the internal oscillations of the electric, magnetic, and displacement fields become mutually coordinated, establishing a persistent dynamical configuration.

The interaction between these two mechanisms may create a local energy minimum.

At such a state, the torus can maintain its geometry and internal dynamics without continuous energy emission.

Stability does not require the internal fields to become static. The energy components may continue to oscillate and exchange energy while the overall structure remains persistent.

Thus, geometrical and resonant saturation provide the proposed physical basis for the existence of stable material particles.

6.3. The Electron as a Stable Toroidal Configuration

Within the proposed model, the electron represents one particular stable configuration of a toroidal energy structure.

During the preceding growth process, repeated merging and radiation allow the torus to reorganize toward increasingly favorable energy states.

Eventually, geometrical and resonant saturation may prevent substantial further transformation through the same growth mechanism.

The electron is associated with such a saturated state, potentially corresponding to the fundamental resonant mode n=1, as considered in the accompanying studies of toroidal field dynamics.

Its persistence results from the mutual compatibility of its geometry, internal oscillations, and binding conditions.

The electron is therefore not regarded as the ultimate or largest possible toroidal structure. It represents one stable state within a broader range of possible energy configurations.

To establish a quantitative identification with the observed electron, the model must ultimately reproduce its mass, electric charge, spin, and magnetic moment.

6.4. The Positron and Opposite Electric Polarity

The positron is proposed to represent a corresponding stable toroidal configuration with an opposite electric polarity.

In this interpretation, electrons and positrons arise from related internal energy structures, while their opposite electric charges reflect differences in the organization or orientation of their electromagnetic fields.

Both configurations are assumed to possess positive internal energy and negative binding energy, with their stability determined by geometrical and resonant conditions.

The model therefore treats the electron and positron as two possible stable outcomes of energy organization.

Their equal masses and opposite charges provide important physical constraints that a complete description of their internal field configurations must satisfy.

6.5. Stability Does Not Exclude Further Transformation

The stability of an electron or positron does not imply that its internal structure is incapable of participating in further physical interactions.

Geometrical and resonant saturation restrict further growth through the original mechanism of torus merging. However, different energy distributions and interaction conditions may permit structural transformations that are inaccessible to an isolated particle.

For example, interactions involving electron-like and positron-like configurations may introduce new field arrangements and energy exchange processes.

Such interactions may produce radiation or lead to other configurations, depending on their dynamics and conservation constraints.

The proposed development of more complex particles lies beyond the scope of the present study.

The present model focuses on the earlier transition from energetically neutral microscopic structures to persistent matter.

6.6. Physical Significance of Stable Matter Formation

The proposed sequence of energy organization can be summarized as follows:

1. Energetically neutral space permits the spontaneous formation of micro-toruses.
2. Individual micro-toruses may persist in neutral equilibrium.
3. Interactions between compatible micro-toruses can initiate merging and energy redistribution.
4. Increasing negative binding energy and electromagnetic radiation permit transitions toward lower internal energy states.
5. Geometrical and resonant saturation may establish persistent configurations identified in the model with electrons and positrons.

This sequence provides a conceptual mechanism through which matter may develop from energy organization without requiring the creation of additional net energy.

The central distinction is between the existence of energy and its organization into stable material structures.

Within the proposed framework, matter represents a persistent form of organized energy, maintained by internal force balance, geometrical constraints, and resonant dynamics.

7. Energy Balance of the Universe

7.1. Zero Total Energy as a Fundamental Axiom

The fifth axiom of the proposed model states that the total energy of the universe is zero and remains unchanged throughout its physical evolution.

$$\boxed{W_{\text{universe}} = 0}$$

This assumption does not imply that the universe contains no energy. Rather, positive and negative energy contributions coexist in such a way that their global sum remains zero.

The model distinguishes three principal energy components: positive energy W_p associated with the internal dynamics of material structures, negative binding energy W_v, and positive electromagnetic radiation energy W_s.

The global energy balance is expressed as

$$\boxed{W_p + W_v + W_s = 0}.$$

Consequently,

$$|W_v| = W_p + W_s.$$

These quantities represent the total contributions of their respective energy components throughout the universe.

Within this framework, physical evolution consists of changes in the magnitude, distribution, and organization of energy rather than changes in its global sum.

7.2. Formation of Energy Structures Without Net Energy Creation

In the proposed model, completely empty space may possess zero positive and negative energy while retaining its energy degree of freedom.

The spontaneous formation of a neutral micro-torus introduces two compensating energy components:

$$0 \longrightarrow W_p + W_v,$$

where

$$W_p = -W_v.$$

The resulting micro-torus contains nonzero internal energy components but retains zero net energy.

Thus, the appearance of an elementary energy structure does not require the creation of additional total energy.

The fundamental distinction is between the creation of energy and the formation of an organized physical structure.

An initially unstructured energy state can become internally differentiated while preserving its zero-energy balance.

7.3. Energy Conservation During Torus Merging

When two compatible toruses merge, their internal fields reorganize into a new configuration.

The merging process may increase the positive internal energy and produce an even greater increase in the magnitude of negative binding energy.

Part of the resulting energy difference is emitted as electromagnetic radiation.

The corresponding conservation equation is

$$\boxed{\Delta W_p + \Delta W_v + W_s = 0},$$

where W_s denotes the radiation emitted during the merging event.

For the proposed growth mechanism,

$$\Delta W_p > 0, \qquad \Delta W_v < 0, \qquad W_s > 0.$$

It follows that

$$\boxed{|\Delta W_v| = \Delta W_p + W_s}.$$

The increase in negative binding-energy magnitude therefore compensates for both the increase in positive internal energy and the emitted radiation.

The net internal energy of the resulting torus may become negative, even though the energy of the complete system, including radiation, remains unchanged.

This mechanism connects the growth of organized energy structures with the conservation of total energy.

7.4. Radiation and the Redistribution of Energy

Electromagnetic radiation has a particular role in the proposed model.

Unlike an isolated neutral micro-torus, a freely propagating electromagnetic wave carries positive energy. Its propagation redistributes energy through space without changing the global energy balance.

When a torus emits radiation during structural reorganization, its internal energy decreases by the amount carried away.

The emitted radiation may subsequently propagate over large distances, interact with other structures, or be absorbed.

These processes change the spatial distribution of energy but do not alter its total sum.

The presence of positive radiation energy therefore requires a corresponding negative contribution elsewhere in the global energy balance.

Within the proposed framework, the increasingly negative binding energy of material structures provides this compensating contribution.

Consequently, the simultaneous accumulation of organized matter and electromagnetic radiation is compatible with the fifth axiom.

7.5. Local Energy States and Global Energy Balance

The energy balance of an individual structure must be distinguished from the total energy balance of the universe.

An isolated neutral micro-torus satisfies

$$W_p + W_v = 0$$

After merging and radiation, a more strongly bound torus may satisfy

$$W_p + W_v < 0$$

Its negative net internal energy is balanced by positive energy transferred to its surroundings, including emitted radiation.

Negative net internal energy does not imply negative inertial mass. In the proposed toroidal model, inertial mass is associated with the combined magnitudes of positive and negative energy contributions:

$$m_i = \frac{W_p + |W_v|}{c^2}$$

Thus, the net energy balance describes the binding state of the torus, whereas the combined absolute energy contributions determine its inertia. This distinction is developed in greater detail in Part A4.

The local energy state can therefore change while the global sum remains zero.

The formation of stable structures does not require every individual particle to possess zero net energy. It requires that all energy changes are compensated within the complete system.

Thus, local energy differentiation and structural stabilization can coexist with global energy conservation.

7.6. A Universe with Zero Energy and Continuing Physical Evolution

The proposed zero-energy principle permits a universe in which physical structures continue to form and develop without a change in the total energy.

Spontaneous energy differentiation may produce neutral micro-toruses. Their subsequent interactions can generate stronger binding, electromagnetic radiation, and increasingly stable configurations.

Through geometrical and resonant saturation, some configurations may become persistent material particles.

The growth of organized matter is therefore interpreted as a change in the distribution and structure of energy rather than an increase in the total energy of the universe.

In this model, the existence of matter does not require a corresponding initial creation of positive net energy. Positive contributions are accompanied by negative binding-energy contributions, maintaining the assumed global balance.

The zero-energy axiom does not, by itself, determine the universe's geometry, expansion history, or large-scale distribution of matter. Nor does it establish the physical origin of the energy degree of freedom.

Nevertheless, within the proposed framework, it provides a consistent accounting principle for investigating matter formation in a universe where space and time already exist.

The following section examines the broader cosmological implications of this interpretation.

8. Cosmological Implications

8.1. Space and Time as Permanent Foundations

The proposed model introduces an alternative conceptual foundation for cosmology. Space and time are regarded as fundamental properties of physical reality, independent of the existence of matter and its transformations.

Consequently, the formation of matter does not require a simultaneous creation of space and time. Physical processes occur within an already existing universe whose energy dimension permits different configurations of positive and negative energy.

The model does not attempt to determine the origin of space and time. Instead, it investigates how matter can emerge, develop, and disappear while the fundamental properties of physical reality remain unchanged.

8.2. The Development of Matter from the First Electrons to the Present

According to the proposed framework, matter develops through the organization of energy into increasingly complex structures.

Spontaneously formed micro-toruses may interact and merge, increasing their positive internal energy and the magnitude of their negative binding energy. Electromagnetic radiation accompanies transitions toward lower internal energy states.

Geometrical and resonant saturation may produce stable toroidal configurations identified in the model with electrons and positrons.

The appearance of these first stable particles represents a fundamental stage in the development of matter. Subsequent interactions and transformations may lead to more complex particles, atoms, molecules, and eventually macroscopic structures.

The model thus proposes a continuous physical history extending from the formation of the first stable material particles to the processes observed in the universe today.

The detailed development of complex matter lies beyond the scope of this article.

8.3. Continuous Formation and Disappearance of Matter

Within the proposed framework, matter is not necessarily created during a single cosmological event.

New material structures may continue to emerge wherever the necessary conditions for energy differentiation, interaction, and stabilization are satisfied.

At the same time, existing material structures may undergo transformations that destroy their original geometrical and resonant organization.

Matter can therefore both form and disappear as a recognizable structure, while its energy components are redistributed into other forms.

Extreme gravitational environments, including black holes, may provide conditions under which such transformations become significant. The possible disintegration of toroidal structures in these environments is suggested as one example, rather than as the exclusive mechanism of matter disappearance.

The proposed disappearance of matter does not imply the disappearance of energy. All transformations remain subject to the global energy balance.

Thus, the universe is described as a system in which the formation, transformation, and disappearance of material structures may occur simultaneously.

8.4. Radiation and the Evolution of Matter

The formation and transformation of matter are accompanied by changes in binding energy and electromagnetic radiation.

When toroidal structures combine into more strongly bound configurations, the increase in the magnitude of negative binding energy may exceed the increase in positive internal energy. The resulting difference is released as radiation.

These processes may occur not only during the formation of elementary particles but also during the development of more complex material structures.

The model therefore suggests that matter formation and transformation may contribute to the electromagnetic radiation observed throughout the universe.

One possible implication concerns the cosmic microwave background. The proposed framework allows radiation to arise directly in the microwave frequency range during suitable energy-reorganization processes.

A complete explanation of the observed background spectrum, temperature, isotropy, and spatial fluctuations would require further development of the theory and is not attempted here.

8.5. Cosmological Observations and Further Research

The proposed framework also opens alternative approaches to the interpretation of cosmological redshift and supernova time dilation.

The Classical Model of Light, developed separately in Part B2, examines the distinction between the frequency, wavelength, and propagation velocity of astronomical light. It proposes measurement methods and physical mechanisms that may provide alternative interpretations of these observations.

The present article does not repeat those analyses.

Likewise, a detailed explanation of cosmic radiation, the formation of complex particles, and the disappearance of matter in extreme environments requires extending the model beyond elementary toroidal structures.

These questions are left for further theoretical and experimental investigation.

The proposed framework must ultimately be evaluated against the full range of cosmological observations, including the cosmic microwave background, the abundance of light elements, and the large-scale distribution of matter. [5, 6]

8.6. A Universe of Continuing Energy Transformation

The proposed model describes the universe as an environment in which energy continuously changes its organization without altering the global energy balance.

Matter emerges when energy becomes organized into persistent structures. It develops through interactions and transformations, and it may disappear when these structures lose their stability or are reorganized into other forms.

The total energy of the universe remains zero throughout these processes.

This interpretation separates the existence of the universe from the existence of matter. Space and time provide the fundamental framework, while matter represents a changing manifestation of energy organization within it.

The model therefore offers a conceptual description of physical evolution extending from the formation of the first stable material particles to the present day, without requiring that all matter originated in a single primordial event.

The central proposition is that matter has a continuing physical history of formation, transformation, and disappearance, whereas the existence of space and time is not dependent on that history.

9. Discussion

9.1. A Different Foundation for Cosmology

The proposed framework approaches cosmology from a different conceptual starting point. Rather than seeking a primordial event responsible for the simultaneous origin of space, time, and matter, it treats space and time as fundamental properties of physical reality.

The model introduces an energy degree of freedom at every point of space, allowing different configurations of positive and negative energy. These configurations may possess identical net energy while differing in their internal organization.

This distinction provides the conceptual basis for the proposed spontaneous formation of microscopic energy structures without requiring the creation of additional net energy.

The central hypothesis is that the existence of the universe and the formation of matter are separate physical questions. Matter may emerge and develop within an already existing universe.

9.2. The Role of the Zero-Energy Principle

The fifth axiom establishes a zero total energy balance for the universe.

Within the proposed model, positive energy associated with material structures and electromagnetic radiation is compensated by negative binding energy.

This principle allows the complexity and distribution of energy to change while its global sum remains constant.

The merging of toroidal structures illustrates the proposed mechanism. Positive internal energy and the magnitude of negative binding energy can increase simultaneously, while the difference is released as radiation.

Consequently, the development of matter does not necessarily require an increase in the total energy of the universe.

However, the global zero-energy condition remains a fundamental assumption of the model. Its physical validity depends on establishing a consistent definition of the negative binding-energy contribution and demonstrating its compatibility with the observed properties of matter and gravitation.

9.3. From Energy Organization to Material Stability

The proposed model distinguishes between the spontaneous formation of energetically neutral micro-toruses and their subsequent development into stable material structures.

An isolated micro-torus may remain in neutral equilibrium. Interactions between compatible structures can introduce forces that reorganize their fields, increase binding, and release electromagnetic radiation.

Repeated interactions may lead to geometrical and resonant saturation. These conditions can establish local energy minima and produce persistent configurations.

Within the model, electrons and positrons are identified as examples of such stable toroidal structures.

Their stability does not imply that further energy transformations are impossible. Rather, it indicates that substantial structural changes through the original growth mechanism have become energetically unfavorable.

The further development of complex matter requires additional physical mechanisms and is outside the scope of the present study.

9.4. Relationship to Electromagnetic Theory

The proposed model associates the dynamics of the energy dimension with electromagnetic fields described by Maxwell's equations.

Maxwellian field theory permits propagating electromagnetic waves and configurations with

toroidal topology, providing a mathematical basis for investigating closed electromagnetic structures.

The model introduces an additional distinction between positive energy and negative binding energy. This distinction is intended to describe the energetic organization and stability of toroidal structures without interpreting the negative binding contribution as a negative quantity of electromagnetic field content.

Nevertheless, the spontaneous formation and persistence of the proposed micro-toruses do not follow directly from Maxwell's equations alone.

A complete formulation must establish the relationship between the electromagnetic fields, the negative binding-energy contribution, and the forces that determine toroidal equilibrium and stability.

9.5. Cosmological Consequences and Observational Constraints

The framework suggests that matter formation and disappearance may occur throughout the physical history of the universe.

Energy released during the formation of increasingly complex structures may contribute to cosmic electromagnetic radiation. The possible connection with the cosmic microwave background provides one direction for further investigation.

Alternative interpretations of cosmological redshift and supernova time dilation have been considered separately in the Classical Model of Light, including the differential measurement approach described in Part B2.

The present study does not attempt a quantitative treatment of these cosmological phenomena.

Any comprehensive extension of the model must account for the observed spectrum and anisotropies of the cosmic microwave background, primordial light-element abundances, large-scale structure, and other established cosmological measurements.

These observations represent essential tests for determining whether the proposed framework can develop into a quantitative alternative to conventional cosmology.

9.6. Open Questions and Further Development

Several issues remain to be addressed in future research.

The first concerns the spontaneous formation of micro-toruses. Although the proposed energy degree of freedom permits multiple energetically neutral configurations, the dynamical conditions governing transitions between them remain to be established.

The second concerns the physical definition of negative binding energy and its relationship to electromagnetic field dynamics. A quantitative formulation is necessary to determine the forces, energy distributions, and stability conditions of the proposed structures.

The third concerns the correspondence between stable toroidal configurations and observed elementary particles. Their calculated properties must reproduce experimentally established quantities such as mass, electric charge, spin, and magnetic moment.

Finally, the broader cosmological consequences of continuous matter formation and transformation require further investigation, including their relationship to cosmic radiation and the observed evolution of large-scale structures.

These questions define the principal directions for developing the present conceptual framework into a predictive physical theory.

9.7. Scope and Significance of the Proposed Framework

The present study is not intended to provide a complete reconstruction of cosmic history. Its

purpose is to establish a limited set of physical axioms and propose a mechanism through which organized matter may emerge in an already existing universe.

The main conceptual contribution is the distinction between zero net energy and the absence of physical structure.

By allowing multiple configurations with the same zero-energy balance, the model proposes a pathway from energetically neutral space to microscopic toroidal structures and subsequently to persistent material particles.

The framework also permits continued transformation and disappearance of matter without violating its assumed global energy conservation principle.

Its significance lies in presenting a coherent conceptual alternative for investigating matter formation independently of a primordial creation event. Its ultimate physical validity depends on quantitative development and experimental verification.

10. Conclusions

This study presents an alternative conceptual framework for the formation and evolution of matter, based on five fundamental physical axioms. Space and time are treated as primary properties of physical reality, while an intrinsic energy degree of freedom allows different energy configurations to exist at every point of space.

A central proposition of the model is that zero net energy does not necessarily imply the absence of physical structure. Positive energy W_p and negative binding energy W_v are considered autonomous components that may assume nonzero values while maintaining a zero-energy balance. This provides the proposed basis for the spontaneous emergence of energetically neutral micro-toruses.

Individual micro-toruses may persist in neutral equilibrium without requiring continuous energy input or emission. When compatible toruses interact, energy-related forces may reorganize their fields into larger structures. The increase in negative binding-energy magnitude can exceed the increase in positive internal energy, allowing the difference to be released as electromagnetic radiation while preserving the total energy balance.

Successive interactions may lead to geometrical and resonant saturation, creating stable energy configurations. Within the proposed model, electrons and positrons represent examples of such persistent toroidal structures. Their formation illustrates a possible transition from energetically neutral space to organized matter without requiring the creation of additional net energy.

The resulting framework describes matter as a changing manifestation of energy organization. Material structures may form, develop, transform, or disappear, while their energy contributions remain subject to the assumed zero-energy balance of the universe. These processes may extend from the formation of the first stable particles to the present day, independently of any proposed beginning of space and time.

The model remains a conceptual hypothesis requiring further mathematical and experimental investigation. In particular, the dynamics of spontaneous micro-torus formation, the origin of negative binding energy, and the quantitative properties of stable toroidal particles must be established. Nevertheless, the proposed axioms provide a foundation for investigating the formation and continuing evolution of matter within an already existing universe.

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