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SINGULAR PHYSICS AS THE MISSING LINK

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«Издательские решения»

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Singular Physics as the Missing Link

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Singular Physics as the Missing Link in the Architecture of the Universe

Abstract

Modern physics is confronted with fundamental contradictions: the nature of dark energy and dark matter remains elusive, a quantum theory of gravity is absent, and the singularities of black holes and the Big Bang indicate the incompleteness of existing models. This review proposes a new paradigm — **Singular Physics** — as the missing link in the architecture of the Universe.

The approach is based on a multilevel structure of reality, where our 3+1-dimensional Universe emerges from a phase transition of a fundamental 2D quantum vacuum. The article provides a detailed analysis of an extended theory of relativity, allowing for superluminal ($v > c$) states and tachyonic fields, alongside modified quantum mechanics with a decoherence operator for wave function collapse in strong gravitational fields.

We present and interpret results from laboratory modeling (Technion experiment, 2026) and astronomical observations (object 1ES 1927+654, event AT2018cow) as evidence for phase transitions and quantum explosions. A hierarchical model is proposed: a 1D primary singularity, a 2D quantum vacuum, and a 3D crystallized space-time. The framework offers a fresh perspective on the dynamics of time, entropy asymmetry, and the quantum nature of reality.

Keywords: singular physics, extended relativity, tachyons, quantum decoherence, multilevel Universe, superluminal barrier, phase transitions, cosmology.

Introduction: The Fundamental Crisis and the Role of Singular Physics

1.1. Statement of the Problem: A Review of Unresolved Questions in Modern Physics

Despite its remarkable successes in describing both the microcosm and the macrocosm, modern theoretical physics is experiencing a profound conceptual crisis. This crisis manifests as a series of fundamental contradictions and unresolved problems that challenge the completeness and internal consistency of existing models.

Key unresolved questions include:

— **The Problem of Dark Matter and Dark Energy.** Observational astronomy convincingly demonstrates that visible (baryonic) matter constitutes only about 5% of the total energy density of the Universe. The remaining 95% is attributed to dark matter (27%) and dark energy (68%). The nature of these components remains unknown. Dark matter is not described by the Standard Model of particles, and dark energy, responsible for the accelerated expansion of the Universe, lacks a satisfactory explanation within the frameworks of General Relativity and quantum field theory.

— **The Problem of Singularities.** General Relativity (GR) predicts the existence of gravitational singularities — points of infinite density and space-time curvature. Such objects arise at the center of black holes and at the initial moment of the Big Bang. At these points, known physical laws cease to function, indicating the incompleteness of GR and the need for a new, more general theory.

— **The Absence of a Quantum Theory of Gravity.** The Standard Model and GR — the two greatest theories of the 20th century — are fundamentally incompatible. Attempts to unify them within a quantum theory of gravity (e.g., string theory, loop quantum gravity) have not yet led to a verifiable and generally accepted model. This hinders our understanding of early Universe physics, the internal structure of black holes, and the very nature of space-time.

These problems indicate that modern physics has reached the limits of applicability of its fundamental paradigms. Resolving these contradictions requires not merely modifying existing theories but revising the very foundations of our understanding of reality.

In this context, *singular physics* is proposed as a new conceptual framework capable of becoming the missing link in the architecture of the Universe. It postulates the existence of a multilevel structure of reality and considers superluminal transitions and dimensional phase transformations as key mechanisms for the evolution of the Universe.

1.2. Hypothesis: Singular Physics as a Universal Theory Unifying Quantum Mechanics, Relativity, and Cosmology

The proposed approach is based on a central hypothesis: singular physics constitutes a universal theoretical framework capable of consistently unifying the key domains of modern fundamental science — quantum mechanics, general and special relativity, and cosmology.

The essence of the hypothesis is that the observed 3+1-dimensional Universe (three spatial dimensions and one temporal) is not the fundamental level of reality, but rather the result of a phase transition from a more fundamental state. This state is a 2-dimensional quantum vacuum, which, in turn, arises from the overcoming of a superluminal barrier by matter and energy originating from a state of primary one-dimensional singularity.

Thus, singular physics postulates a multilevel architecture of the Universe, where each level is characterized by its own fundamental laws and space-time dimensionality:

— **One-Dimensional Level (Primary Singularity):** A state of absolute compression, preceding the birth of familiar dimensions. Here, all interactions occur instantaneously (outside of time), and the only mode of evolution is a discontinuous leap over the superluminal barrier.

— **Two-Dimensional Level (Quantum Vacuum):** An ocean of tachyons that emerged as a result of overcoming the barrier. At this level, cause-and-effect relationships are replaced by non-local correlations (quantum entanglement), and interaction with gravity or an observer leads to decoherence and the collapse of the 2D superposition into 3D reality.

— **Three-Dimensional Level (Crystallized Space-Time):** Our familiar world, where linear time and three-dimensional space emerge as a way to structure the flow of tachyons. The laws of the Standard Model and General Relativity are considered as a special, low-energy limit of the more general laws of singular physics.

This hypothesis offers a new perspective on the nature of dark matter and energy (as manifestations of tachyonic fields of the two-dimensional level), provides a solution to the problem of singularities (by considering them as phase transition points between levels), and lays the foundation for a quantum theory of gravity, where gravity acts as a decoherence operator linking different dimensional realities.

1.3. Object and Subject of Research

Within this work, the object and subject of research are clearly delineated, allowing for a focused scientific analysis of the key aspects of the proposed hypothesis.

The **object of research** is the fundamental laws of nature. This is the most general category, encompassing all principles and regularities governing the behavior of matter, energy, space, and time at all scales of the Universe — from subatomic particles to entire cosmological structures. The research is directed towards discovering deeper, universal principles underlying known physical theories.

The **subject of research** is the specific mechanisms and processes that, according to the proposed hypothesis, ensure the formation of a multilevel structure of reality. In particular, the focus is on:

— **Mechanisms for the transition of matter and energy through the superluminal barrier ($v > c$).** This includes the theoretical description of physical conditions under which overcoming the speed of light becomes possible, as well as an analysis of changes in the properties of matter (e.g., the emergence of an imaginary rest mass) during transition into a tachyonic state.

— **Processes for forming a multilevel structure of reality.** The subject of analysis is phase transitions between different dimensional levels of the Universe: from a primary one-dimensional singularity to a two-dimensional quantum vacuum and the subsequent crystallization of three-dimensional space-time.

Thus, if the object is the very “architecture” of natural laws, then the subject is the “construction processes” and “technologies” (in a physical sense) that create the observed complexity and hierarchy of the Universe.

1.4. Methodology: Synthesis of Theoretical Physics, Mathematical Modeling, and Astronomical Data Analysis

To construct and verify the new theoretical paradigm outlined in this work, a comprehensive, interdisciplinary methodology is applied. It is based on a synthesis of three key approaches that allow not only for formulating a hypothesis but also for checking its consistency and correspondence with observable reality.

— **Synthesis of Theoretical Physics.** The foundation of the research is the development of new mathematical and conceptual tools. This stage includes:

— Generalization of relativity and quantum mechanics: formulating an extended theory of relativity that allows for superluminal ($v > c$) states and imaginary mass, as well as modifying

the Schrödinger equation to account for strong gravitational fields through the introduction of a decoherence operator.

— Construction of tachyon field theory: postulating a scalar field with negative mass as a carrier of dark energy and a key element of the two-dimensional level of reality.

— **Mathematical Modeling.** The developed theoretical apparatus is implemented in rigorous mathematical models that allow for quantitative analysis and obtaining verifiable consequences. This stage includes:

— Derivation of energy transition equations: calculating the energy required to overcome the light barrier and analyzing the behavior of physical quantities in the superluminal region.

— Modeling phase transitions: creating models describing both the collapse of 3D structures into 2D vacuum and subsequent crystallization.

— **Analysis of Astronomical Data.** A key element of the methodology is comparing theoretical predictions with observational results. This approach provides empirical significance to the hypothesis. The analysis is conducted in two directions:

— Laboratory modeling: critical review and interpretation of experimental results on observing superluminal group velocities (e.g., Technion experiment, 2026) as possible laboratory confirmation of tachyonic states.

— Observational astronomy: comparing theoretical models with data on transient cosmic phenomena. In particular, we analyze the disappearance of an accretion disk around object 1ES 1927+654 and characteristics of event AT2018cow (“the Cow”) as potential astrophysical manifestations of phase transitions and quantum explosions predicted by singular physics.

It is this integrated approach, combining fundamental theory, rigorous mathematical apparatus, and observational verification, that ensures the scientific validity and novelty of this work.

Section I. The Theoretical Foundation: The Architecture of New Physics

Chapter 1. Extended Relativity Theory and the Superluminal Barrier

1.1. Analysis of Lorentz Transformations: The Speed of Light Limit and Its Physical Interpretation

The foundation of modern relativistic physics lies in the Lorentz transformations, which describe how spatial and temporal coordinates change when transitioning between inertial reference frames moving at a constant velocity relative to each other. A key element of these transformations is the relativistic factor, traditionally denoted by the Greek letter gamma (γ).

In its standard form, this factor is defined as:

$$\gamma = 1 / \sqrt{1 - v^2/c^2},$$

where:

- v is the relative velocity of the object,
- c is the fundamental constant, the speed of light in a vacuum.

The analysis of this expression's behavior as the object's velocity approaches the speed of light ($v \rightarrow c$) is of fundamental importance.

— **The Causality Limit.** As v approaches c , the denominator of the fraction, $\sqrt{1 - v^2/c^2}$, tends toward zero. This causes the value of γ to increase without bound, approaching infinity. Physically, this means that accelerating any object with a rest mass to the speed of light would require infinite energy. Thus, the speed of light is not merely a speed limit, but a fundamental barrier that separates causally connected events within our 3-dimensional space-time. The light cone, defined by the speed c , outlines the boundaries beyond which the classical concept of causality ceases to function.

— **The Mathematical Discontinuity.** The formula for γ contains the expression $(1 - v^2/c^2)$ under the square root. For $v > c$, this expression becomes negative, and consequently, the factor γ becomes an imaginary number (it contains the imaginary unit i). Within the framework of standard relativity theory, this is interpreted as the non-physicality of superluminal motion for ordinary particles.

Singular physics offers an alternative interpretation of this mathematical fact. The imaginary nature of relativistic quantities for $v > c$ is not considered a prohibition, but rather an indication of matter transitioning into a qualitatively new state that lies outside the light cone of the 3D continuum. This state is characterized by an imaginary rest mass and is described as a tachyonic state. Consequently, within the extended theory of relativity, the speed of light limit is not a wall, but a threshold; crossing it requires overcoming an energy barrier and is accompanied by a change in the fundamental properties of matter and its dimensionality.

1.2. The Superluminal Domain: The Concept of Imaginary Rest Mass and the Tachyonic State

Overcoming the light barrier ($v > c$) within standard physics is considered impossible, as it leads to mathematical and physical paradoxes, such as imaginary energy and a violation of causality. However, in the context of extended relativity theory and singular physics, this “prohibition” is re-interpreted not as a fundamental limitation, but as a transition of matter into a fundamentally new, superluminal state known as the tachyonic state.

The key concept describing this state is that of an imaginary rest mass.

Physical Interpretation of Imaginary Mass

In relativistic mechanics, a particle's total energy E and its momentum p are related to its rest mass m_0 and velocity v through the following relationship:

$$E^2 = (m_0^2 * c^4) + (p^2 * c^2).$$

For ordinary particles (bradyons) with a rest mass $m_0 > 0$ and a velocity $v < c$, this equation always yields a real, positive value for energy. However, if we assume that a particle's velocity exceeds the speed of light ($v > c$), then for the formula to remain mathematically consistent, the square of the rest mass must be negative: $m_0^2 < 0$. This means that the rest mass m_0 itself must be an imaginary number.

We introduce the notation: $m = i * m_0$, where:

— i is the imaginary unit ($i^2 = -1$);

— m_0 is a real quantity, which can be called “tachyonic mass.”

With this substitution, the energy equation takes the form:

$$E^2 = (-m_0^2 * c^4) + (p^2 * c^2).$$

Since for a superluminal particle its momentum p (which also becomes imaginary) is such that the term $(p^2 * c^2)$ has a greater absolute value than $(m_0^2 * c^4)$, the total energy E remains a real and positive quantity. Thus, an imaginary rest mass does not make a particle non-physical; rather, it is an inherent property of matter in its tachyonic mode.

The Tachyonic State as an Exit from the Light Cone

An object with an imaginary rest mass — a tachyon — possesses properties that are paradoxical from the standpoint of classical physics:

— **Speed:** A tachyon cannot move slower than the speed of light. Its velocity is always $v > c$.

— **Energy and Momentum:** Unlike ordinary particles, for a tachyon, energy does not increase to infinity as its speed increases; on the contrary, it decreases. As its velocity tends toward infinity, a tachyon's energy tends toward zero.

— **Causality:** Motion at a speed exceeding that of light formally leads to a violation of familiar cause-and-effect relationships within a single light cone.

Within singular physics, the tachyonic state is interpreted not as a violation of the laws of nature, but as matter exiting the light cone of 3-dimensional space-time. This is a transition to a more fundamental level of reality — the two-dimensional quantum vacuum. In this new state, our familiar concepts of time and causality are transformed: they are replaced by non-local quantum correlations. Thus, a tachyon is not simply a “fast particle,” but rather a carrier of a new physical quality that links different dimensional levels of the Universe.

1.3. The Energy Transition Equation: Justification for the Reality of the Transition at $v > c$

The central element of the theory describing the overcoming of the light barrier is the **energy transition equation**. It determines the amount of energy required to transfer matter from its familiar 3-dimensional state into the tachyonic state of a 2-dimensional quantum vacuum.

The derivation of this equation is based on a generalization of the relativistic energy expression and an account for the change in space-time topology at the moment of a phase transition.

Derivation and Structure of the Equation

The equation for the energy of a quantum leap (E_{qs}) is written as follows:

$$E_{qs} = \Delta m \cdot c^2 / \sqrt{1 - (c^2/v^2)}$$

where:

— Δm — mass defect, that is, the difference between the rest mass of the initial object and its effective mass at the moment of transition. This energy, according to the principle of mass-energy equivalence, is the “fuel” for the phase jump.

— c — the speed of light in a vacuum.

— v — the velocity of the object at the moment of overcoming the barrier ($v > c$).

A key point for analysis is the behavior of the denominator $\sqrt{1 - (c^2/v^2)}$ upon entering the superluminal region.

Justification for the Reality of the Transition

.Analysis of the Denominator. At speeds less than the speed of light ($v < c$), the expression under the root ($1 - c^2/v^2$) is positive, and the equation describes the dynamics of an ordinary relativistic particle. However, as the velocity approaches the speed of light (v

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