The new physical theory about gravitational time dilation

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Abstract

Time is a fundamental physical concept underlying classical mechanics, relativity theory, quantum field theory, and modern models of elementary particles and cosmology. Despite its central role, the physical nature of time and the mechanisms governing its dependence on gravitation remain subjects of ongoing discussion. In particular, numerous experiments have demonstrated gravitational time dilation, yet their physical interpretation is commonly restricted to geometric descriptions within the framework of General Relativity.

In this work, experimental results on gravitational time dilation are briefly reviewed from the viewpoints of classical physics and General Relativity. On this basis, the main principles of a new "P**hysical theory of gravity"** are proposed. The theory offers a physical interpretation of time as a quantity determined by internal processes in matter influenced by gravitational fields, rather than as a purely geometric coordinate. Within this approach, gravitational time dilation is interpreted because of the interaction between gravitation and the internal electromagnetic and structural properties of material systems.

The proposed framework not only provides a physically motivated interpretation of the observed gravitational influence on time but also offers an alternative view on the nature of gravitation itself and its action on material bodies. These results may contribute to the development of a more comprehensive physical theory of gravitation in the future.

Keywords: *gravity; time; gravitational time dilation; physical theory of gravitation; electromagnetic field; internal structure of matter.*

1. Introduction

1.1 Time as a Physical Quantity

Time is one of the fundamental concepts of natural sciences. As a physical quantity, it is defined operationally through periodic processes occurring within a chosen reference frame. Such processes allow the comparison of changes in the states of physical systems and enable the measurement of durations associated with natural phenomena using a standardized time scale.

In practice, time is measured by reproducible physical processes, typically associated with electromagnetic or atomic transitions, which serve as reference standards. Consequently, time is not observed directly but inferred from the behavior of physical systems [1–3].

1.2 Concepts of Time in Modern Physics

Classical physics. In classical mechanics, time is treated as an absolute, continuous, and invariant quantity, independent of spatial position and physical conditions. Physical processes are assumed to unfold within a three-dimensional Euclidean space characterized by orthogonal coordinates X, Y, Z. The passage of time is uniform and unaffected by the properties of material bodies or fields [4,5].

Within this framework, time serves as an external parameter governing the evolution of physical systems. Conservation laws for energy and momentum are formulated in three-dimensional space, while time provides a universal measure of duration applicable to all processes.

The modern unit of time, the second, is defined in the International System of Units (SI) by the frequency of electromagnetic radiation associated with the hyperfine transition of the ground state of the cesium-133 atom [6,7]. This definition emphasizes the close connection between time measurement and electromagnetic processes.

General Theory of Relativity (GTR). In General Relativity, time is no longer an absolute quantity but is treated as a coordinate of four-dimensional spacetime. Gravitation is interpreted as a manifestation of spacetime curvature caused by mass–energy, and the gravitational field is encoded in the metric tensor of pseudo-Riemannian geometry [8–11].

Within this geometric framework, the rate of time depends on gravitational potential. Clocks located in regions of stronger gravitational fields run slower relative to clocks situated at higher gravitational potential. As a result, time becomes a relative quantity whose rate varies from point to point in spacetime.

1.3 Experiments on Time Dilation under Gravitation.

Gravitational time dilation is confirmed by several experimental studies aimed at testing the effect of decreased gravitational potential with increasing altitude above Earth, which causes clocks to run slower at the Earth's surface than at higher altitudes.

Experiments:

(i) **Hafele-Keating Experiment**: This experiment demonstrated a time difference between the average values of clocks on two airplanes flying in opposite directions and those on the Earth's surface [15].

For small changes in the gravitational field associated with altitude changes, the approximate time dilation expression is used to compare a clock on the Earth's surface (T_E) with one at height h above the surface (T). Hafele and Keating predicted a time difference of 144 ns for an eastward flight around the world, lasting 41.2 hours at an average altitude of 8900 m. For a westward flight lasting 48.6 hours at an average altitude of 9400 meters, the predicted value was 179 ns.:

$$T - T_E = \frac{gR}{c^2} T_E \qquad (1)$$

where: T_E - clock on the Earth's surface, T- clock above Earth's surface at distance h,
$g = 9.8$ m/s^2, $R = 6.38\ 10^6$ m (mean radius), $c = 3\ 10^8$m/s.

(ii) **Gravity Probe A Experiment**: This experiment measured the difference in clock rates between a satellite at an altitude of 10,000 kilometers and the Earth's surface, with data showing a time delay with an error margin of 0.007%. Subsequent observations of Galileo satellites reduced this error by a factor of 5.6, refining gravitational redshift test results from 1976 [16].

(iii) **Hidetoshi Katori Experiment**: This experiment observed a lag of 4.3 nanoseconds per day between synchronized optical atomic "bottom clocks" on the first floor of the Tokyo Sky Tree skyscraper and "top clocks" 450 meters above the Earth's surface [17].

(iv) **GPS Satellites**: Time corrections are applied to clocks on GPS satellites at an altitude of about 20,000 km, which run faster than clocks on Earth. The time delay for Earth clocks is 38 microseconds per day [18,19,20,21]

(v) **Holger Muller's Experiment at UCLA**: This experiment demonstrated time dilation due to Earth's gravity. Cesium atoms, moving upward relative to Earth's surface under two laser beams, entered a superposition of states with different impulses. The gravitational influence varied with height, causing phase overlaps of the wave function to differ when returning to the starting point. These variations caused atomic interference within the cloud, showing alternating densification and rarefaction measured by laser beams. This confirmed the effect of time dilation under Earth's gravity with high accuracy (of the order of $7 \cdot 10^{-9}$) in 2011 [22,23].

1.4 Interpretation of Experimental Results.

From a **classical physics** perspective, time itself is not considered a physical entity possessing intrinsic properties. Observed changes in clock rates under gravity may therefore be interpreted as the influence of gravitational fields on the physical mechanisms of clocks or on the properties of the surrounding medium. In this view, gravity affects material systems rather than time as an independent quantity.

In **General Relativity**, gravitational time dilation is attributed exclusively to the curvature of spacetime. The slowing of clocks is interpreted as a direct consequence of the metric properties of spacetime, independent of the internal structure or physical composition of the clock.

1.5 Motivation for Physical Interpretation.

While General Relativity provides a highly successful mathematical description of gravitational time dilation, it does not explicitly address the physical mechanisms by which gravitation influences the rate of internal processes in material systems. Classical physics, in turn, lacks a comprehensive theory of gravitation capable of explaining the observed effects.

These limitations motivate the search for a physical interpretation of gravitational time dilation that connects gravitation with the internal structure and dynamics of matter. The present work proposes such an interpretation as part of a new physical theory of gravity, which is introduced in the subsequent sections.

2. Problems of Modern Theories of Gravitation

2.1 Newtonian Gravitation

Within classical physics, gravitational interaction is described by Newton's law of universal gravitation. According to this law, gravitation is treated as a force interaction directly proportional to the masses of the interacting bodies and inversely proportional to the square of the distance between them. Each material body possessing mass is assumed to generate a gravitational field in the surrounding space.

$$F = G \cdot \frac{m_1 \cdot m_2}{r^2}, \qquad (2)$$

where G is the gravitational constant $6.67430 \cdot 10^{-11}$ *m³/(kg·s²).*

Despite its high practical effectiveness in describing the motion of bodies in weak gravitational fields, Newtonian gravitation does not reveal the physical nature of gravitation nor the mechanism by which gravitational interaction between material bodies is realized. This theory does not provide a physical explanation of how gravitation may influence the internal physical processes that determine the measurement of time. As a result, its applicability to the analysis of gravitational time dilation remains fundamentally limited [24].

2.2 Modern Theories of Gravitation.

Modern theories of gravitation can be categorized into two main groups:

(a) Geometrical Interpretation: This group interprets gravitation as a geometrical effect based on the properties of "spacetime," as demonstrated in the General Theory of Relativity (GTR) and other complementary theories [25,26].

(b) Alternative Gravitational Theories: These include relativistic (RTG), quantum, covariant, and other theories [27…37].

Group (a): Geometrical Interpretation. Theories in this group do not view gravitation as a force interaction between material bodies but as a manifestation of the "curvature" of the four-dimensional spacetime continuum under the influence of masses. Gravitation is identified with the metric tensor of Riemannian space, leading to the rejection of the gravitational field as a physical field in favor of the geometry of space with curved geodesic lines. This approach leads to partial inconsistencies with quantum mechanics, as GTR does not explain how the mass of matter curves space, an explanation that conflicts with quantum mechanics. Attempts to present space as discrete in various complementary theories also lack physical explanation.

Conceptually, Einstein's equations can be represented as an equality between geometry (left side) and energy (right side):

$$R_{\mu\upsilon} - \tfrac{1}{2} R\, q_{\mu\upsilon} = 8 \pi G\, T_{\mu\upsilon}/C^4 \qquad (3)$$

where $R_{\mu\upsilon}$ - is the Ricci tensor, $q_{\mu\upsilon}$ - is the metric tensor, $T_{\mu\upsilon}$ - is the energy-momentum tensor.

The task of solving equations (3) is to find an explicit form of the metric tensor $q_{\mu\upsilon}$ that fully characterizes the geometry of space-time based on the energy-momentum tensor $T_{\mu\upsilon}$ and initial conditions. Gravity is identified with the metric tensor of Riemannian space in general relativity, which leads to the rejection of the gravitational field as a physical field with a transition to the geometry of space with curvature of geodesic lines. GTR does not explain how the mass of matter curves space, which is fundamentally inconsistent with quantum mechanics. Attempts to represent space as discrete in a few other complementary theories also have no physical explanation.

Group (b): Alternative Gravitational Theories. Theories in this group describe gravitation as a real physical field, explaining its nature through mechanisms such as the emission and interaction of unknown particles ("gravitons" in RTG), the "pushing" of bodies by other particles, Coulomb interaction of charges, photon emission, or the properties of space filled with unknown matter like cosmic particles or one-dimensional energy "strings." Gravitational phenomena are considered within the framework of flat Minkowski space, where the laws of conservation of energy-momentum and momentum are unambiguously fulfilled.

2.3 Limitations, Approximations, and Open Questions.

Despite differences in foundational assumptions and interpretations, geometrical and alternative theories of gravitation often lead to similar quantitative results within the limits of applicable approximations. This circumstance suggests that existing theories primarily describe observable manifestations of gravitation rather than its fundamental physical mechanism.

In many cases, explanations of gravitational phenomena rely on concepts that themselves lack a complete physical interpretation, such as spacetime curvature, hypothetical interaction carriers, or unspecified properties of the vacuum. Consequently, key questions remain unresolved, including the physical mechanism of gravitation formation, the nature of gravitational interaction between material bodies, the influence of gravitation on the rate of physical processes that define time, and the description of gravitation at the quantum level.

At present, no single theory of gravitation provides a fully consistent and experimentally grounded physical explanation of this fundamental interaction across all length and energy scales. In this sense, existing theories of gravitation may be regarded primarily as highly effective mathematical models that successfully describe observed phenomena without fully revealing the underlying physical nature of gravitation.

3. Results.

3.1 Main Points of the New "Physical Theory of Gravity".

Today, there are ample objective scientific observations and experimental data on the structure of matter, its properties, and various interactions at both macro and micro levels to explain the physical nature of gravitation. We propose that rather than seeking fundamentally new properties of matter that form and react to the gravitational field through mutual attraction, it is sufficient to study the known properties of matter and its constituents (particles, molecules, and atoms) that create and respond to physical fields.

The proposed "Physical Theory of Gravity" provides a physical explanation of the nature of gravitation and the action of the gravitational field on material bodies, integrating modern understandings of the structure of matter. This theory could form the basis for a general theory of gravitation in the future. Our research addresses critical gaps in understanding gravitation, laying the groundwork for a physical theory that explains the genesis of gravitational fields and the dynamics of gravitational interactions among material bodies, while incorporating established scientific concepts about the structure of matter [38].

3.2 Key insights of the theory include:

(i) The central postulates of the theory are as follows:

- the gravitational field is a physical field of electromagnetic nature.

- the gravitational field is not a conventional electromagnetic field; however, it arises because of electrodynamic processes within matter, including the motion, oscillation, and rotation of charged particles in atomic, nuclear, and plasma structures.
- each atom and charged particle generates a gravitational field that can be represented as a superpositions of independently propagating radially pulsating electric and magnetic fields ("E" and "H" fields) with discrete frequency spectra determined by the quantum structure of matter.
- the resulting gravitational field of a macroscopic body exhibits a radial multimode structure formed by the superposition of such pulsating fields emitted by all atoms and particles composing the body.

(ii) In the present model, gravity is not associated with longitudinal electromagnetic waves in the conventional sense. Instead, it is related to independently propagating radially pulsating electric and magnetic fields, considered as non-radiative field configurations rather than coupled electromagnetic waves. These fields do not require the presence of transverse components and do not form a Poynting vector or electromagnetic momentum transport.

The characteristic frequency scales of these pulsations are comparable to those of the X-ray and gamma ranges (approximately 10^{19}–10^{23} Hz), however, the proposed fields are not photon-mediated radiation and do not produce ionizing effects. Their high penetrating ability is associated with the absence of induced charge redistribution and eddy currents in conductive materials [5,6].

(iii) The proposed Physical Theory of Gravity is formulated as a phenomenological framework aimed at providing a physically motivated description of gravitational interaction and its coupling to matter. The primary objective of this approach is not to replace existing geometric descriptions of gravity, such as general relativity, but to complement them by introducing explicit physical mechanisms associated with the internal structure and dynamics of matter.

In contrast to purely geometric interpretations, the present framework treats gravity as a real physical field arising from electrodynamic processes occurring within matter at atomic, nuclear, and plasma scales. These processes include the motion, oscillation, and rotation of charged constituents, which collectively generate time-dependent field configurations extending into the surrounding space. According to the proposed model, each atom and charged particle contributes to the gravitational field through the emission of independently propagating, radially pulsating electric and magnetic field components. These components are not interpreted as conventional transverse electromagnetic waves, but as non-radiative field configurations associated with localized energy oscillations. Their characteristic frequencies are determined by the quantum and nuclear structure of matter and form a discrete multimode spectrum.

The gravitational field of a macroscopic body is described as a superposition of such radially pulsating field contributions emitted by all constituent particles. This superposition results in a structured, multimode field exhibiting radial symmetry on average, while allowing for local temporal and spatial variations. Within this interpretation, gravitational interaction emerges as a collective effect of microscopic electrodynamic processes rather than as a purely geometric property of spacetime. An important feature of the proposed theory is the distinction between gravitational fields and conventional electromagnetic radiation. Although the gravitational field is associated with electric and magnetic components, it does not involve energy transport in the form of propagating electromagnetic waves and does not generate a Poynting flux. As a result, these fields exhibit high penetrating ability and weak interaction with matter in comparison to ordinary electromagnetic radiation.

The proposed framework seeks to preserve the empirical successes of existing gravitational theories while addressing conceptual gaps related to physical mechanism, causality, and interaction at microscopic scales. In this sense, the Physical Theory of Gravity should be regarded as a complementary physical interpretation that may serve as a basis for further theoretical development and experimental investigation.

3.3 Mechanism of Gravitational Interaction with Matter.

Within the proposed framework, gravitational interaction is interpreted as the response of matter to an external multimode field composed of radially pulsating electric and magnetic components. These components originate from the collective electrodynamic activity of surrounding matter and act on atomic and subatomic systems without transferring energy in the form of propagating electromagnetic waves.

When matter is placed in an external gravitational field, its internal electric and magnetic structures interact with the time-dependent field components. The pulsating electric component induces polarization of bound charge systems, leading to periodic displacement of electron clouds relative to atomic nuclei. Simultaneously, the pulsating magnetic component interacts with magnetic moments associated with orbital and spin angular momentum of charged particles.

Atoms, nuclei, and subatomic particles possessing angular momentum may therefore be treated as microscopic gyroscopic systems. Under the influence of external time-dependent fields, these systems experience torques that modify their precessional motion. This response is analogous to known effects such as Larmor precession but arises here from a superposition of pulsating electric and magnetic fields rather than from static external fields.

At the macroscopic level, the collective precessional response of many microscopic systems results in a net directed force acting on the center of mass of a body. This force is oriented toward the source of the external gravitational field and manifests as gravitational attraction. In this interpretation, gravity emerges as a cumulative effect of microscopic field–matter interactions rather than as an instantaneous action at a distance.

The equivalence of inertial and gravitational mass follows naturally from this framework. Inertial forces arise when matter resists acceleration due to mechanical disturbance, while gravitational forces arise from the interaction of matter with external pulsating fields. In both cases, the magnitude of the response is determined by the same internal structural properties of matter, leading to proportionality between inertial and gravitational mass.

From a quantum-mechanical perspective, the presence of an external gravitational field perturbs the internal symmetry of atomic and nuclear potential. This perturbation induces anisotropy of the corresponding wave functions and modifies probability density distributions, in a manner analogous to known perturbative effects such as the Stark and Zeeman effects. The resulting anisotropy contributes to modified angular momentum dynamics and to the effective force acting on matter.

3.4 Scope, capabilities, and perspectives of the proposed Physical Theory of Gravity.

The Physical Theory of Gravity offers a complementary physical interpretation of gravitational interaction by emphasizing mechanisms associated with the internal structure and dynamics of matter. While the present formulation is phenomenological, it provides a coherent conceptual framework linking microscopic electrodynamic processes to macroscopic gravitational effects. A key advantage of this approach is the establishment of a direct connection between microscopic dynamics and observable gravitational phenomena, without relying exclusively on geometric abstraction. The theory also provides a physically transparent interpretation of the equivalence principle, treating inertial and gravitational mass as manifestations of the same underlying response of matter to external influence.

Time-dependent variations of gravitation are interpreted as amplitude modulation of an underlying physical field. This viewpoint establishes continuity between static gravitational interaction and its dynamic manifestations and may offer alternative physical interpretations of gravitational variability while remaining consistent with empirical observations.

The proposed framework does not aim to replace General Relativity or other established theories, which remain indispensable for quantitative predictions. Instead, it seeks to supplement existing descriptions by addressing conceptual questions related to physical mechanism, causality, and interpretation. In this sense, the Physical Theory of Gravity may serve as a basis for further theoretical refinement and targeted experimental investigation.

4. Time Dependence on Gravity in Three-Dimensional Space.

4.1 Physical Origin of Gravitational Attraction and Its Influence on Time.

Within the proposed Physical Theory of Gravity, gravitational attraction arises from the interaction of matter with a structured physical field composed of radially pulsating electric and magnetic components. These field components act on all material systems and influence the dynamics of internal physical processes. As a result, gravity affects not only spatial motion but also the duration of processes, which provides a physically transparent basis for understanding gravitational time dilation.

In this framework, time is not treated as an independent entity or a separate physical substance. Instead, it is understood operationally as a measure of the duration of physical, chemical, and biological processes occurring in matter. Consequently, any systematic influence of gravity on the rates of such processes manifests itself as a change in the measured flow of time.

4.2 Experimental Evidence and Standard Interpretations.

A wide range of experiments demonstrate that the duration of physical processes depends on gravitational potential. An increase in gravitational field strength is consistently associated with a slowing of clock rates and other time-measuring processes.

In **classical physics**, gravity is regarded as acting solely on material bodies, while time itself is treated as an abstract parameter. As a result, classical mechanics does not provide a physical mechanism linking gravity to changes in time.

In **General Relativity**, gravitational time dilation is attributed to the curvature of four-dimensional spacetime caused by mass–energy. In this geometric interpretation, time varies as a coordinate of spacetime rather than because of direct interaction between gravity and material systems.

While both approaches successfully describe experimental results, they do not explicitly address the physical mechanisms by which gravity influences the internal dynamics of matter.

4.3 Interpretation within the Physical Theory of Gravity.

Within the Physical Theory of Gravity, the dependence of time on gravity is interpreted because of the action of the gravitational field on all material objects in three-dimensional space. Time is regarded as a quantitative measure of change in the physical world, determined by the duration of processes occurring in matter.

An increase in gravitational field strength leads to a systematic increase in the duration of physical processes. This effect arises because the gravitational field modifies the internal dynamics of matter, influencing particle mobility, polarization, and angular momentum dynamics at microscopic scales. As a result, the rates of physical and chemical transformations decrease, and the measured flow of time slows accordingly.

In this cause-and-effect relationship, gravity acts as the primary agent influencing material systems, while time emerges as a secondary quantity reflecting the duration of their evolution.

4.4 Explanation of the increase in duration of physical and chemical phenomena due to gravity.

The "Physical Theory of Gravity" provides an explanation for the increase in the duration of physical and chemical phenomena and related processes under the influence of gravity near the Earth's surface. This explanation is based on well-known scientific observations of physical, chemical, and nuclear kinetics [40…47]:

(a) Chemical and Nuclear Reactions:

Chemical Reactions: Homogeneous and heterogeneous chemical reactions occur when atoms and molecules collide. In these reactions, new substances with different properties from the reactants are formed, with changes occurring in the electron shells of the substances, while the atomic nuclei remain unchanged.

Nuclear Reactions: These involve changes in the atomic nuclei of the reacting elements, resulting in the formation of atoms of new elements. The rate of nuclear reactions depends on the collisions of the nuclei of the reacting substances.

The rate of these reactions is determined by two main factors:

- Number of Collisions: This depends on the concentration of the reacting substances and their mobility.

- Probability of Transformation: This depends on the energy of the colliding substances.

The rate of reactions quantitatively characterizes their speed, i.e., their duration. As the level of gravity increases, the duration of chemical and nuclear reactions increases. This is because the rate of reactions involving nuclei, atoms, or molecules depends on their activation energy and inert mass. An increase in gravity reduces the mobility of particles and increases the activation energy required for reactions, resulting in slower chemical and nuclear reactions due to fewer collisions of reacting substances.

From a quantum perspective, the physical field of gravitation, represented by longitudinal pulsating electric and magnetic fields ("E"- and "H"- fields with frequencies ranging from 10^{19} to 10^{23} Hz), leads to partial polarization of the wave functions of the atoms of reacting substances. This increases their stability due to the precession of the magnetic moments of nuclei and electrons. Under the influence of a gravitational field in the form of longitudinal pulsating "E"- and "H"- fields, the wave function of the electron in atoms changes. The state of the electron is determined by the forces acting on it from the atomic nucleus and the external gravitational force. This change in the wave function of the atomic electron leads to an increase in the duration of chemical reactions.

Analysis of chemical and nuclear reactions. Analysis of known chemical and nuclear reactions indicates that their duration depends on the level of gravity. An increase in gravity generally slows down the reaction time.

In summary, the "Physical Theory of Gravity" explains how the physical field of gravity affects the duration of physical and chemical processes. The increase in gravitational levels reduces particle mobility and increases energy activation, leading to slower reaction rates and longer durations for chemical and nuclear reactions. This explanation aligns with observed phenomena and provides a comprehensive understanding of gravity's impact on the duration of various processes.

(b) Physical phenomena in nature:

Physical phenomena in nature are characterized by changes in the shapes, sizes, or aggregate states of material bodies. The rate of these reactions depends on the mobility, structural stability, and masses of the material bodies involved in the interaction process. An increase in the gravitational field level leads to an increase in the inert mass of matter and a decrease in the mobility of material bodies, which explains the increase in the duration of physical reactions in nature.

A special group of physical phenomena stages, however, shows that an increase in the level of gravity can lead to an increase in their speed. Examples include:

- The frequency of pendulum oscillations.
- The pressure exerted by a body on its base under gravity.
- Acceleration of certain stages of earth cataclysms.

In these stages, gravity acts as a dominant force that accelerates the physical process. Despite this, the overall duration of physical phenomena increases with increasing gravity levels.

(c) Plant growth:

Plant growth, which involves both chemical (photosynthesis and respiration) and physical (transpiration) changes, slows down as gravity increases. The chemical reactions in plant growth convert light, water, and carbon dioxide into oxygen and glucose, which are used as energy. Transpiration involves the movement of water from the soil to the plant roots and leaves, where it is released as water vapor. An increase in gravity slows the rate of these reactions, thereby slowing plant growth.

(d) Processes in living organisms:

An increase in the level of gravity slows down the processes in living organisms that sustain their life. Despite the diversity of life forms, all organisms share common features in their life activities, which are based on physical and chemical processes. These processes include metabolism, protein synthesis, and regulation of genetic information, all of which occur at the molecular level within cells.

The effect of gravity on living organisms is similar to its effect on all material bodies in nature, leading to a slowdown in their development.

(e) Nervous system and human thought:

An increase in gravity leads to slower reactions of the nervous system and the human development process. The brain is a complex neural network that produces and processes a vast number of electrochemical impulses. These impulses are responsible for human thought, which is based on the properties of neurotransmitters forming functional chains for information transmission and processing.

Neurons communicate through synapses, where electrical signals are transmitted by neurotransmitters. The speed of thought is determined by the speed at which nerve impulses are transmitted through synaptic connections. The chemical and electrical activity of the brain is crucial for the formation of consciousness and memory. An increase in the gravitational field slows down the rate of these activities, leading to a slowdown in all thought processes and the perception of the surrounding world.

In summary, the "Physical Theory of Gravity" explains how the physical field of gravity affects the duration of various physical and chemical processes. As gravity increases, it reduces particle mobility, increases energy activation, and slows down reaction rates, resulting in longer durations for these processes. This comprehensive understanding aligns with observed phenomena in nature and living organisms.

4.5 Research conclusions: features of gravitational time dilation.

(i) Biological and complex systems.

Living organisms rely on intricate networks of physical and chemical processes, including metabolism, signal transmission, and molecular synthesis. Since these processes are governed by the same physical principles as non-living systems, changes in gravitational conditions may influence their characteristic timescales.

An increase in gravitational field strength is therefore expected to slow biological processes qualitatively, including growth, metabolic activity, and neural signal transmission. In nervous systems, where information processing depends on electrochemical signal propagation, reduced reaction rates and transport speeds may lead to slower response times and altered perception of temporal intervals.

These considerations are intended as qualitative physical implications rather than as detailed biological models.

Under Earth’s gravitational conditions, the influence of gravity on the duration of physical and chemical processes is extremely small compared to dominant electromagnetic and kinetic effects. As a result, gravitational time dilation is measurable only with highly precise instruments, such as atomic clocks, and manifests itself at the level of nanoseconds.

The dependence of process duration on gravity is inherently nonlinear. Significant deviations from Earth's gravitational field would lead to disproportionate changes in reaction rates and system dynamics, potentially resulting in profound modifications of physical, chemical, and biological behavior.

In this context, the Physical Theory of Gravity emphasizes that gravitational time dilation does not require exotic concepts such as time loops or temporal discontinuities. Instead, it emerges naturally from the influence of gravity on the duration of real physical processes.

(ii) Chemical and Nuclear Reactions:

- **Earth's Gravity and Matter Stability:** The gravitational field of Earth affects matter by increasing the stability of nuclei, atoms, and molecules. This stability is enhanced due to the precession of their magnetic moments within the physical gravitational field and the resultant increase in inert mass.
- **Activation Energy and Reaction Duration:** Earth's gravity raises the activation energy of nuclei, atoms, molecules, and other particles by polarizing the wave functions of electrons in the direction of the gravitational field. This polarization decreases the activity of particle interactions and slows down the duration of reactions. However, this slowing down effect is minimal under Earth's gravity because the gravitational force here is much weaker compared to the dominant electrostatic forces and kinetic energy of molecules that primarily determine the rate of chemical reactions.
- **Significant Gravitational Increase:** If the gravitational field level were significantly increased beyond Earth's gravity, the rate of chemical reactions would substantially decrease. This is due to the increased energy activation in molecules and changes in their average orientation, leading to fewer collisions necessary for reactions. Consequently, the duration of all reactions and chemical processes in both living and non-living nature would increase.

(iii) Physical Reactions:

- **Dominance of gravity in physical processes:** Earth's gravity is the dominant force in many physical processes. The speed of these reactions depends on the mobility, structural stability, and masses of material bodies involved in interactions. An increased gravitational field level leads to an increase in the mass of matter and a decrease in the mobility of material bodies, which explains the lengthening duration of physical phenomena as gravity increases.
- **Phenomena duration under Earth's gravity:** The duration of all phenomena occurring under Earth's gravity has been studied and conforms to the established laws of physics and chemistry.

(iv) Experimental Observations

- **Atomic clocks and gravitational potential:** Well-known experiments with atomic clocks have demonstrated that they show different times at different altitudes, which have varying gravitational potentials on Earth. These time differences are extremely small, measured in nanoseconds, indicating a minimal but measurable impact of gravitational potential on time.
- **Nonlinear dependence on gravity:** The duration of all phenomena in nature depends nonlinearly on the level of gravity.
- **Disproportionate changes in phenomena duration:** Changes in gravity levels lead to disproportionate changes in the duration of various reactions and phenomena in nature. Any significant increase or decrease in gravity compared to Earth's conditions results in distortions in the natural world, affecting plant and animal life, the nervous systems of living organisms, and the cognitive processes of intelligent beings.
- **Expansion of the universe due to the repulsion of stars:** Expansion of the universe due to repulsion of stars: At resonance of frequencies of pulsations of external "E"- and "H"-fields emitted by one mass, for example, a star, and frequencies of rotation of particles with huge kinetic energy in the state of plasma of another mass, these particles are repelled from the source of the field. In this case there is no procession of particles in the other mass and instead of gravitational attraction between these two masses there is gravitational repulsion, the so-called "antigravity". Such interaction is possible between objects from high-temperature plasma, such as stars. This explains the expansion of space on the scale of the entire Universe due to gravitational repulsion of stars.
- **Peculiarities of gravitational time dilation:**

- Under Earth's gravitational conditions, the influence of gravity on the duration of physical and chemical processes is extremely small compared to dominant electromagnetic and kinetic effects. As a result, gravitational time dilation is measurable only with highly precise instruments, such as atomic clocks, and manifests itself at the level of nanoseconds.

- The dependence of process duration on gravity is inherently nonlinear. Significant deviations from Earth's gravitational field would lead to disproportionate changes in reaction rates and system dynamics, potentially resulting in profound modifications of physical, chemical, and biological behavior.

- In this context, the Physical Theory of Gravity emphasizes that gravitational time dilation does not require exotic concepts such as time loops or temporal discontinuities. Instead, it emerges naturally from the influence of gravity on the duration of real physical processes.

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