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New Discovery on Planck Units and Physical Dimension in Cosmic Continuum Theory

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Abstract

In 1899, Max Planck integrated the Planck constant h with the gravitational constant G and the speed of light c, discovered a set of physical constants, and created Planck Units System. Since 20th century, the development of physics made the gravitational constant, the speed of light, and the Planck constant the most important fundamental constants of physics representing classical theory, relativity, and quantum theory, respectively. Now, the Planck Units have been given new physical meanings, revealing the mysteries of many physical boundaries. However, more than 100 years have passed, Planck Units System not only failed to get rid of the incompatibility between the basic theories of physics, but also cannot surpass the limitations of existing physics theories. In Cosmic Continuum Theory, physical dimensions can be transformed under the principle of equivalence. Planck units system not only integrates into the axiom system of Cosmic Continuum Theory, but also establishes a benchmark for the unity of physical dimensions. The introduction of the abstract physical dimensions "JX" and "XJ" makes the physical dimension of existence quantity and dimension quantity unified respectively.

Keywords

1. Introduction

The fundamental constants of physics are the passwords of the universe and important scientific discoveries. Among all the physical constants, the well-known gravitational constant G, speed of light c, and Planck constant h are the three most fundamental constants of physics. These three fundamental con-

stants of physics represent the different epoch-making basic theory of physics respectively. The gravitational constant G represents classical theory, the speed of light c represents relativity, and the Planck constant h represents quantum theory.

However, because these three basic theories of physics have different logical preconditions, they are regarded as three different cosmologies. There are disputes between high speed and low speed, macroscopic and microscopic, continuous and discrete between the three parties, and no consensus has been reached so far.

Cosmic Continuum Theory is an axiomatized physics system built on the mathematical continuum model. In Cosmic Continuum Theory, the universe is a continuum consisting of an existence continuum and an existing dimension continuum. The existence continuum is composed of mass bodies, energy bodies and dark mass bodies. The existing dimension continuum is composed of space, time and dark space. Mass, energy and dark mass are collectively called the existence quantity, and the quantity of space, time and dark space is called the dimension quantity [1] [2] [3].

This theory holds that a fundamental constant of physics should not only serve a certain physical basic theory. As cosmic codes of physics that gradually discovering in the course of continuous advancement, they are human's basic understanding of the natural world and should be an important basis for the unity of physics.

It was Max Planck himself who tried to unify fundamental constants of physics and achieved remarkable success. In 1899, he combined the Planck constant h with the gravitational constant G and the speed of light c, and found a series of physical constants. These physical constants are the so-called Planck units, and the following four constants are related to the existence quantity and the dimension quantity [4].

1) Planck mass: $m_p = \sqrt{hc/G} \approx 2.17651 \times 10^{-8}$ (kg).
2) Planck energy: $E_p = \sqrt{hc^5/G} \approx 1.9561 \times 10^{9}$ (J).
3) Planck time: $t_p = \sqrt{hG/c^5} \approx 5.39106 \times 10^{-44}$ (s).
4) Planck length: $l_p = \sqrt{hG/c^3} \approx 1.61619 \times 10^{-35}$ (m).

They are given corresponding physical meanings, such as: the mass of the ground state particles cannot be greater than the Plank mass; the energy cannot be greater than or equal to the Planck energy, otherwise it will collapse into a black hole; Planck time is an observable event Minimum process time; Planck length is a measure of Plank's quality black hole, unable to distinguish events within a distance less than Planck length; unable to describe events occurring within Planck time when the universe was born, etc. However, the Planck Unit cannot resolve the logical contradiction with the continuous space-time of the theory of relativity, because the space-time structure derived from Planck's length and Planck's time is discontinuous. Even for quantum field theory, Planck length and point particle models are in conflict [5]-[21].

2. The Physical Boundaries and Their Conversion of Planck Units System

In the following, we include the Planck units in the axiom system of Cosmic Continuum Theory for discussion.

2.1. Fundamental Concepts and Lemmas

This article uses the fundamental concepts and axioms system in [1]. The following lemmas are cited in [1], these lemmas will be used in later proofs.

Lemma 1: The existence quantity has its elementary unit e_{min} (Proof see [1]).

This lemma is equivalent to the quantification hypothesis.

Lemma 2: The interaction force between the initial fields of the existences Z_1 and Z_2 is: $f \sim Z_1 Z_2 / r^2$, and the action direction is along the line connecting Z_1 and Z_2, where, r is the distance between Z_1 and Z_2 (Proof see [1]).

This lemma contains the law of universal gravitation. When the existence is a mass body, the theorem is the law of universal gravitation.

Lemma 3: An existence has a maximum speed and the speed of an energy body is the maximum speed (Proof see [1]).

This lemma includes the speed of light postulate.

Lemma 4: An existence has a maximum frequency υ_{max} (Proof see [1]).

Lemma 5: When the particle reaches its maximum speed, it will be converted to a quantum; when the particle or quantum reaches its maximum frequency, it will be transformed into dark particle (Proof see [1]).

Lemma 6: The existence quantities of mass m and energy $E = mc^2$ are equivalent: $m \equiv E$. "$\equiv$" is the "equivalent" symbol (Proof see [1]).

This lemmas contain mass-energy relation $E = mc^2$.

Lemma 7: The dimension quantity of 1-second of time is equivalent to that of c-kilometer space: 1 second $\equiv c$ km, where, c indicates the speed of light (Proof see [1]).

Lemma 8: In a cosmic system A, the elementary particle, elementary quantum and elementary dark particle have equivalent inertia size: $m_{min} \equiv q_{min} \equiv d_{min}$ (Axiom in [1]).

Lemma 9: A dimension quantity has its elementary units w_{min}, and the dimension quantities of elementary space quantity s_{min}, elementary time quantity t_{min} and elementary dark space quantity w_{min} are equivalent: $w_{min} \equiv s_{min} \equiv t_{min} \equiv g_{min}$ (Proof see [1]).

Lemma 10: The existences are coupled with each other by energy, And in the presence of different structural levels, by the corresponding quantum from the role of convergence. If there is a structure at the structural level of the quantum of q connection, e the corresponding amount of existence, the corresponding structure of the particle m, dark particle d is also the amount of e: $m \equiv d \equiv q \equiv e$ (Axiom in [1]).

Lemma 11: There are only three basic forms of existence: particle, quantum,

and dark particle (Axiom in [1]).

Lemma 12: The interaction force between the initial fields of the existences Z_1 and Z_2 is: $f \sim Z_1 Z_2 / r^2$, and the action direction is along the line connecting Z_1 and Z_2, where, r is the distance between Z_1 and Z_2 (Proof see [1]).

2.2. Derivation

1) Planck mass m_p

According to Lemma 2, the gravitational potential energy of two existing bodies with a distance of r and a mass of m is Gm^2/r, where G is the gravitational constant.

Let the vibration period of mass body m be t, then its frequency is:

$$\upsilon = 1/t \tag{1}$$

Also set its speed to V, then its movement distance in a period t is:

$$r = Vt \tag{2}$$

The search for Planck unit is to define the boundaries of physical events. According to Lemma 3, the velocity boundary of the microscopic particles is the speed of light c, so the change in the gravitational potential energy between the two bodies of Planck mass m_p in one cycle t should be:

$$\lim_{V \to c} Gm_p^2 / (Vt) = Gm_p^2 / (ct) \tag{3}$$

According to Lemma 1, the quantification hypothesis, we get:

$$Gm_p^2 / (ct) = h\upsilon \tag{4}$$

Substituting (1) into (4) yields:

$$Gm_p^2 / (ct) = h/t \tag{5}$$

From the formula (5), we can get the Planck mass m_p:

$$m_p = \sqrt{hc/G} \tag{6}$$

2) Planck energy E_p

Planck energy E_p can be obtained from Lemma 6:

$$E_p = m_p c^2 \tag{7}$$

Substituting (6) into (7)) gives Planck energy E_p:

$$E_p = \sqrt{hc^5/G} \tag{8}$$

3) Planck time t_p

According to Lemma 1, the Planck time t_p can be found by:

$$E_p = h\upsilon_p \tag{9}$$

where υ_p is the frequency of the Planck time t_p period:

$$\upsilon_p = 1/t_p \tag{10}$$

Substituting (10) into (9) yields:

$$E_p = h/t_p \tag{11}$$

Substituting (8) into (11) yields:

$$\sqrt{hc^5/G} = h/t_p \tag{12}$$

Obtain t_p from (12):

$$t_p = \sqrt{hG/c^5} \tag{13}$$

4) Planck length l_p

Planck length l_p can be obtained from Lemma 7:

$$l_p = t_p c \tag{14}$$

Substituting formula (13) into formula (14) yields:

$$l_p = \sqrt{hG/c^3} \tag{15}$$

2.3. Corollary

Conversion is one of the core ideas of Cosmic Continuum Theory. The mutual transformation of mass, energy, and dark mass makes the universe colorful. However, these transformations are not arbitrary, but are determined by the existence boundaries of particles, quantum, and dark particles. With the mutual conversion between particles, quantum, and dark particles, space, time, and dark space also follow.

Corollary 1: When the mass of particles reaches Planck mass m_p, the particles are converted into quantum and the mass is converted into energy.

Proof: From (3), we can see that Planck mass m_p is obtained by taking the speed as a variable to obtain the limit. According to Lemma 5, when the particle reaches the limit velocity c, it will turn into a quantum. According to the concept in [1], the energy body is a body composed of quantum, so when Planck mass is m_p, the mass has been transformed into energy. Q.E.D.

Corollary 2: When quantum energy reaches Planck energy E_p, quantum is transformed into dark particles and energy is converted into dark mass.

Proof: According to corollary 1, $m_p \equiv E_p$. From (3), we can see that Planck mass m_p is obtained by taking the particle velocity as a variable and finding the limit. However, it is impossible for the particles to reach the limit velocity c, so that the mass of the particles cannot reach Plank mass m_p, and thus the quantum cannot reach Planck energy E_p. According to Lemma 4, the quantum frequency has a maximum value. As a limit value, if the quantum energy reaches Planck energy E_p, the frequency υ_p of the quantum must reach a maximum value of υ_{max}. According to Lemma 5, when the quantum reaches the maximum frequency, it turns into a dark particle. According to the concept in [1], the dark mass is a body composed of dark particles. Therefore, when the quantum reaches a maximum frequency of υ_{max}, Planck energy E_p is converted to a dark mass. Q.E.D.

Corollary 3: Planck mass m_p is equivalent to Planck energy E_p: $m_p \equiv E_p$.

Proof: From (7), we can see that Planck energy E_p is obtained from Planck's mass m_p based on Lemma 6, according to Lemma 6, then $m_p \equiv E_p$. Q.E.D.

Corollary 4: When the amount of time is less than or equal to Planck time t_p, the time is converted to dark space.

Proof: From (9), we can see that Planck time t_p is derived from the Planck energy E_p and the frequency υ_p of the quantum. However, to reach Planck energy E_p, the frequency υ_p of the quantum must reach a maximum of υ_{max}. According to corollary 2, the quantum is transformed into dark particles and the energy is converted into dark mass. According to the concept in [1], dark space is the existence dimension of dark masses. Therefore, when the amount of time is less than or equal to Planck time t_p, the time will be converted into a dark space. Q.E.D.

Corollary 5: When the amount of space is less than or equal to Planck length l_p, the space is converted to a dark space.

Proof: From (14), Planck length l_p is the distance traveled at the speed of light in Planck time t_p. According to corollary 4, when time is less than or equal to Planck time t_p, time has been converted to dark space. Therefore, when the amount of space is less than or equal to Planck length l_p, the space will also be converted into a dark space. Q.E.D.

Corollary 6: Planck time t_p is equivalent to Planck length l_p: $t_p \equiv l_p$.

Proof: From (14), we can see that Planck length l_p is obtained from Planck time t_p based on Lemma 7. According to Lemma 7, then $t_p \equiv l_p$. Q.E.D.

The above 6 inferences fully demonstrate that Planck units do not have any logical contradictions and conflicts in the continuum of the universe and can perfectly express the physical boundaries and their transformation.

3. Unity of Physical Dimensions

The Planck unit system cleverly integrates the three fundamental constants of physics of Planck constant *h*, gravitational constant *G*, and speed of light *c*, and realized their dimensionless processing. Unfortunately, the physical significance of Planck units system is far from being fully reflected due to the inconsistency between the existing physical basic theories.

3.1. New Understanding of the Benchmark Value of Planck Units

The establishment of any physical dimension must be based on a certain benchmark. There are two kinds of benchmarks, one is the maximum, such as the speed of light *c*; the other is the minimum, such as the Planck constant *h*. There are many such benchmarks in the Planck units.

Corollary 7: The elementary unit of energy is $q_{min} = h$ J. *h* is Planck constant.

Proof: According to Lemma 1 and Formula $E = h\upsilon$, where *E* refers to the energy of the quantum and υ refers to the frequency of the quantum, it can be known that Planck constant *h* is actually the energy of the unit frequency. This

means that any energy body cannot be less than energy h, so Planck constant h is the elementary unit of energy. Q.E.D.

Corollary 8: The elementary unit of mass is $m_{min} = h/c^2$ kg. h is Planck constant, and c is the speed of light.

According to Corollary 7, the elementary unit of energy is $q_{min} = h$. According to Lemma 8, the inertia of elementary particles and elementary quanta in an universe system is equivalent: $m_{min} \equiv q_{min}$. According to Lemma 6, the existence quantities of mass m and energy $E = mc^2$ are equivalent: $m \equiv E$, so $h = m_{min}c^2$. From this, we get: $m_{min} = h/c^2$. Q.E.D.

Corollary 9: The elementary unit of time is $t_{min} = t_p$ s. t_p is Planck time.

Proof: According to corollary 4, when the time is less than or equal to Planck time t_p, the time is converted to dark space. This shows that Planck time t_p is the minimum value of time. That is, the elementary unit of time dimension $t_{min} = t_p$. Q.E.D.

Corollary 10: The elementary unit of space is $s_{min} = l_p$ m. l_p is Planck length.

Proof: According to Corollary 5, when the length is less than or equal to Planck length l_p, the space is converted to dark space. This shows that Planck length l_p is the minimum value of space. That is, the elementary unit of length $s_{min} = l_p$. Q.E.D.

Corollary 11: The maximum value of frequency is $\upsilon_{max} = 1/t_p$ Hz. t_p is Planck time.

Proof: According to corollary 9, the elementary unit of time is $t_{min} = t_p$, t_p is Planck time. This means that for any vibration cycle of the existing body T: $T \geq t_p$, and frequency $\upsilon = 1/T$, so for any frequency: $\upsilon = 1/T \leq 1/t_p$, ie. $\upsilon_{max} = 1/t_p$. Q.E.D.

Corollary 12: The maximum value of quantum energy is $E_{max} = E_p$ J. E_p is Planck energy.

Proof: According to Corollary 11, the maximum value of frequency is $\upsilon_{max} = 1/t_p$, t_p is the Planck time. The energy of quantum is $E = h\upsilon$, h is Planck constant, so $E_{max} = h\upsilon_{max} = h/t_p$. By (11), we can see that $E_p = h/t_p$, therefore $E_{max} = E_p$. Q.E.D.

Corollary 13: The maximum value of particle mass is $m_{max} = m_p$ kg. m_p is Planck mass.

Proof: According to Lemma 10, The existences are coupled with each other by energy, And in the presence of different structural levels, by the corresponding quantum from the role of convergence. If there is a structure at the structural level of the quantum of q connection, the corresponding structure of the particle m is also the amount of q: $m \equiv q$. According to corollary 3, Planck mass m_p is equivalent to Planck energy E_p: $m_p \equiv E_p$. This shows that m_p and E_p are in the same structure level. According to corollary 12, The maximum value of quantum energy is $E_{max} = E_p$, E_p is Planck energy. That is, E_p is at the maximum structural level. Therefore, m_p is also at the structural level of

maximum, that is, m_p is the maximum value of particle mass: $m_{max} = m_p$. Q.E.D.

Corollary 7-13 allows us to obtain the elementary unit of energy, the elementary unit of mass, the elementary unit of time, the elementary unit of space, the maximum of frequency, the maximum of quantum energy, and the maximum of particle mass 7 limit constants, this shows that the Cosmic Continuum Theory further develops the benchmark value of the Planck units.

3.2. Equivalent Abstract Physical Dimension

In the system of Planck units, the values of h, G, c and Planck units are all equal to 1, and the mass-energy equation is simplified to $E = m$. It looks a bit similar to Lemma 6: the existence quantities of mass m and energy $E = mc^2$ are equivalent: $m \equiv E$. In reality, it is not. The former is a numerical simplification and is a non-dimensionalized process, represented by the "=" symbol. The latter is the physical equivalent of mass and energy, and it is the unity of physical dimensions, represented by the "≡" symbol. In Lemma 6, the physical dimension of m is kilogram, and the physical dimension of E is Joule; When it satisfies $E = mc^2$, $m \equiv E$ expresses: $m \, \text{kg} \equiv E \, \text{J}$.

Corollary 14: The physical dimensions of existence quantity can be unified on abstract physical dimensions.

Proof: According to Lemma 1, Lemma 8, the elementary unit of mass m_{min}, the elementary unit of energy q_{min}, and the elementary unit of dark quality d_{min} equivalence, which results in the existence of the elementary unit of quantity e_{min}: $e_{min} \equiv m_{min} \equiv q_{min} \equiv d_{min}$.

Set $e_{min} = 1 \, \text{JX}$, then:

$$1 \, \text{JX} \equiv m_{min} = h/c^2 \, (\text{kg}) \tag{16}$$

$$1 \, \text{JX} \equiv q_{min} = h \, (\text{J}) \tag{17}$$

$$1 \, \text{JX} \equiv d_{min} \, \text{Unit} \tag{18}$$

Due to the fact that there is no international standard unit for the amount of dark mass, it is temporarily replaced by "Unit". According to Lemma 11, there are only particle, quantum, and dark particle three basic forms, thus we have unified the physical dimension of existence quantity to an abstract physical dimension "JX":

$$e_{min} = 1 \, \text{JX} \equiv h/c^2 \, \text{kg} \equiv h \, \text{J} \equiv d_{min} \, \text{Unit} \tag{19}$$

So the physical dimensions of existence quantity can be unified on abstract physical dimensions. Q.E.D.

Corollary 15: The physical dimensions of dimension quantity can be unified on abstract physical dimension.

Proof: According to Lemma 9, the elementary unit of space s_{min}, the elementary unit of time t_{min}, and the elementary unit of dark space g_{min} are equivalent, so as to produce the elementary unit of dimension w_{min}: $w_{min} \equiv s_{min} \equiv t_{min} \equiv g_{min}$.

Set $w_{min} = 1 \, \text{XJ}$, then:

$$1\,\text{XJ} \equiv t_{\min} = t_p = \sqrt{hG/c^5}\ (\text{s}) \tag{20}$$

$$1\,\text{XJ} \equiv s_{\min} = l_p = \sqrt{hG/c^3}\ (\text{m}) \tag{21}$$

$$1\,\text{XJ} \equiv g_{\min}\ \text{Unit} \tag{22}$$

Similarly, there is currently no international standard unit for the amount of dark space, it is temporarily replaced by "Unit". According to Lemma 11, there are only three basic forms of particle, quantum, and dark particle. According to Concept 4, Concept 5, and Concept 6, there are also only three basic dimensional forms: space, time, and dark space. Therefore, we have unified the physical dimension of dimension quantity to an abstract physical dimension "XJ":

$$w_{\min} = 1\,\text{XJ} \equiv \sqrt{hG/c^5}\ \text{s} \equiv \sqrt{hG/c^3}\ \text{m} \equiv d_{\min}\ \text{Unit} \tag{23}$$

So the physical dimensions of dimension quantity can be unified on abstract physical dimension. Q.E.D.

Corollary 16: All changes in the universe can be equivalent on abstract physical dimensions.

Proof: All changes in the universe are changes in the quantity and dimension of existence. According to Corollary 14, the physical dimensions of existence quantity can be unified on abstract physical dimensions; and according to Corollary 15, the physical dimensions of dimension quantity can be unified on abstract physical dimension. According to Lemma 8 and Lemma 9, the unity of physical dimensions is based on physical equivalence, so all changes in the universe can be equivalent on abstract physical dimensions. Q.E.D.

Obviously, this physical dimensions system is exactly the same as the Planck Units System. However, the two physical dimensions "JX" and "XJ" are essentially different from our existing physical dimensions. Existing physical dimensions are specific physical dimensions, including Planck units. There is no connection between different specific physical dimensions. But the "JX" and "XJ" are abstract physical dimensions. The function of an abstract physical dimension is to achieve the unity of specific physical dimensions.

3.3. A New Interpretation of Gravitational Redshift

The following is an attempt to solve the gravitational redshift problem by applying the equivalent unified scheme of physical dimensions proposed in this paper.

We know that the energy of a photon E is:

$$E = h\upsilon \tag{24}$$

h is the Planck constant and υ is the photon frequency. According to Lemma 6, The existence quantities of mass m and energy $E = mc^2$ are equivalent: $m \equiv E$. Therefore:

$$E = h\upsilon \equiv mc^2 \tag{25}$$

c is the speed of light. So we can get:

$$m \equiv h\upsilon/c^2 \tag{26}$$

According to Lemma 12, it can be seen that the photon escapes from a certain celestial body M to a distant place of R, and the change of gravitational potential energy E_p is:

$$E_p = -GMm/R \tag{27}$$

G is the gravitational constant. According to corollary 14, the physical dimensions of existence quantity can be unified on abstract physical dimensions. Substituting (26) into (27) gives:

$$E_p = -GMh\upsilon/Rc^2 \tag{28}$$

The amount of change in the gravitational potential energy of a photon is the amount of energy change of this photon. According to the formula (24), if the photon frequency change amount is υ_p, then:

$$\upsilon_p = E_p/h \tag{29}$$

Substituting (28) into (29):

$$\upsilon_p = -GM\upsilon/Rc^2 \tag{30}$$

Deform (30) to get:

$$\upsilon_p/\upsilon = -GM/Rc^2 \tag{31}$$

The result is consistent with the gravitational redshift formula derived by general relativity. This shows that the introduction of the concept of relativistic mass is equivalent to the unification of physical dimensions.

4. Conclusion

The new fundamental constants of physics often represent a new basic theory of physics, and the logical unity of basic physical constants is essentially the unity of physics. The Planck system of units profoundly reveals the physical boundary problem, but it has always been constrained by inconsistencies between the basic theories of physics. In Cosmic Continuum Theory, Planck Units System completely escapes the incompatibility of the physical basis. The axiomatization of Planck Units System enables the logical unity of fundamental constants of physics that represent different physical foundations to be realized. In particular, based on Planck unit, 7 limit constants were deduced, giving a unified benchmark for physical dimensions. The introduction of abstract physical dimensions "JX" and "XJ" to achieve unity of physical dimensions will sweep away another barrier for the unification of physics.

Conflicts of Interest

I declare that there is no competing Interest.

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