

# Cosmic Continuum Theory: A New Idea on Hilbert's Sixth Problem

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## Abstract

Hilbert's sixth problem "The mathematical treatment of the axioms of physics" is a century-old problem that still plagues the scientific community. It is a solution necessary to establish a unified axiom of the basic theories of physics according to the characteristics of a mathematical axiomatic system needed to solve this problem. The cosmic continuum hypothesis can make classical theory, quantum theory and relativity have common logical foundation. According to this model, the universe is a continuum formed by the existence continuum and the existence dimension continuum. Their movement and changes can be described by an axiomatic system. The concrete steps are as follows: 1) Construct the axiom system of a cosmic continuum and establish the basic theory of force. 2) Construct the axiom system of action at a distance and establish the basic theory of field. 3) Based on the axiom system of force and field, the axiom system of the branches of physics is established.

## Keywords

Hilbert's Sixth Problem, Cosmic Continuum, Force, Field, Axiomization

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## 1. Introduction

In 1900, at the Second International Congress of Mathematicians in Paris, German mathematician Hilbert presented 23 problems in his famous speech entitled "Mathematical Problems", which were based on the achievements and trends of 19th century mathematical studies. These became known as Hilbert's problems. Hilbert's problems have been profoundly influencing and promoting mathematical research since the twentieth century, and almost every settlement of a Hilbert problem has made a significant advancement in mathematics. However, there are still about half of Hilbert's problems that have not been resolved, or

have only been partly resolved [1].

After Hilbert's sixth problem was put forward, many revolutionary achievements have been made in physics. Especially in the 1910s century, celestial mechanics evolved into general relativity; in the 1920s, the mechanics of microscopic systems evolved into quantum mechanics. This makes the logical difficulty of this problem greatly increase. Although Hilbert himself and some scientists have achieved some results in general relativity, quantum mechanics, probability theory, modern quantum field theory, fluid mechanics, etc., but it is still far from a solution [2]-[15].

The essence of Hilbert's sixth problem is not to realize the axiomatization of various physical theories, but to build a unified physical axiom that reflects the essential laws of nature. The key to solving Hilbert's sixth problem is to find a unified basic presupposition of physics on the basis of various physical theories. This basic presupposition is implied in the existing theories of physics, but has not as yet been fully revealed.

## 2. Cosmic Continuum Hypothesis

Newton defined all existences, in his time, to be matter. That is, a body of matter is the reason why he was able to unify the theories of physics. Mass refers to the amount of matter, and the effect of all existences is the effect of these masses. All other characteristic properties, such as momentum, angular momentum, heat, electric quantity and energy are subordinate to the amount of matter. Therefore, in classical theory, the law of conservation of mass is also called the law of the indestructibility of matter. Since matter is the existence, space is the existing dimension of matter. The integration by Newton of his three laws of motion and the law of universal gravitation within the Euclidean geometry system, finally gave birth to classical physics [16].

What resulted in a revolution of classical physics is the discovery of "mass defect", which undermines the "law of conservation of matter" in classical science. Einstein worked out that part of mass is converted into energy, which is the secret of mass defect, thus saving physics that was on the brink of collapse and by amending the law of the conservation of mass to be a mass-energy equivalence. With the discovery of  $E = mc^2$ , he further created the theory of relativity [17]. On the other hand, Planck revealed another secret of energy during the course of his blackbody radiation studies. He found that energy comes in little packets, finding Planck's constant  $h$ , which led to the development of the quantum theory of physics [18]. These two theories presently serve as the two pillars of modern physics.

Here we have to explore the truth of nature.

The correct application of  $E = mc^2$  should be to attach the same importance to the energy as to that of the mass and recognize the same mechanical effect of energy as that of mass. That is, when  $E = mc^2$ ,  $E$  and  $m$  equivalent, expressed with  $E \equiv m$ , so that we achieve the unity of quality and energy. The introduction

of “invariant mass” and “relativistic mass” in the theory of relativity has actually proved this point. In fact, relativistic mass refers to energy and invariant energy refers to mass. That is, in any reference frame, the mechanical effect of an existence is related to the mass of matter as well as the energy it generates during movement. As a result, whether the reference system is an inertial or a non-inertial one is irrelevant.

In such a system, the mass remains the one defined by Newton, namely, the amount of substance; while the energy is that generated during movement. That should involve the following natural philosophical question: if the mass and energy are parallel, then the matter and motion are the parallel existence. That is the case. The existence includes a mass body, that is, the existence is represented by mass and composed of matter particles. It also includes an energy body, that is, the existence is represented by energy and composed of energy quantum.

Since energy is a dynamic quantity associated with movement, all changes of movements in the universe are driven by an energy change. Therefore, non-pure movement can never exceed pure movement in speed, which is the real reason why the velocity of light is insurmountable. Suppose what will occur if a particle moves at the velocity of light. Based on the above discussion, the particle will be transformed into a quantum. The mass is completely converted into energy as only pure movement can reach the velocity of light. This reveals another secret of the universe: that energy is the ultimate form of mass.

Planck discovered that the size of energy quanta is determined by the frequency, and the higher the frequency, the greater the energy quantum, namely,  $E = h\nu$  ( $h$  is Planck’s constant,  $\nu$  the frequency of quantum). According to the quantum theory of space-time, time comes in little packets. There is a basic amount of time  $t_{\min}$  and that means that there exists a maximum frequency  $\nu_{\max} = 1/t_{\min}$  in the universe. The question is, when the frequency of a quantum reaches the maximum value  $\nu_{\max}$ , will the quantum be converted into another form of existence? Similarly, the particle has a vibration frequency, and when the frequency of that vibration reaches its maximum value, will the particle be converted into another form of existence?

When the particle or quantum reaches its maximum frequency value  $\nu_{\max}$ , it means that the particle or quantum has shielded itself in the minimum time period. The particle or quantum in such a case will become an existence shielded in the minimum time period. Such a maximum form of particles and quanta already has existed beyond space-time. It cannot even be seen or felt. It cannot even be directly detected by instruments but can be recognized and derived logically [19] [20]. Accordingly, we call that form of existence “dark particle”, and the amount of this “dark particle” is the “dark mass”. Its dimension is related neither to space nor to time, we call it “dark space”.

Based on the above discussion, we get three kinds of existences in the universe, namely, the mass body, energy body and the dark mass body, which can be transformed into each other.

Based on quantum theory, the universe is quantized, that is, the mass body is composed of “particles”, the energy body by “quanta” and the dark mass body by “dark particles”. Further, such particles, quanta and dark particles are not infinitely divisible, but limited within boundaries. In other words, there exists elementary particles, elementary quanta and elementary dark particles. Thus, from a mathematical perspective, all particles, quanta and dark particles in the universe can build up to a denumerable set.

Particles, quanta and dark particles, though transformable into each other, will never be eliminated. This law once was called the indestructibility of matter, the conservation of mass in the Newtonian era, and the mass-energy conservation in the Einsteinian era. Here we name it the existence conservation. This existence includes mass, energy and dark particle. The indestructibility of existence indicates that the universe is eternal and infinite. In this infinite universe, the denumerable set composed of all particles, quanta and dark particles is an infinite set, mathematically called the denumerable infinite set. The denumerable infinite set is discontinuous, which is the logical basis of quantum theory.

Yet set theory has proved that the power set of the denumerable infinite set is a continuum. Then are all existences in the universe the power set of the denumerable infinite set? The answer is yes, as the so-called power set refers to a collection of all the sub-sets of a set. Obviously, the subsets of the denumerable infinite set are composed of all particles, quanta and dark particles in the universe still belonging to the universe, therefore, all existences in the universe are exactly the power set of such a denumerable infinite set, and according to the proof of set theory, all the existences in the universe form a continuum.

Since the space, time and dark space are respectively the existing dimensions of the mass body, energy body and the dark mass body, the three bodies are all quantized and can respectively constitute a continuum of the existing dimension.

From the above discussion, we conclude the following basic presupposition of physics.

**Cosmic continuum hypothesis:** 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.

According to Cosmic continuum hypothesis, the universe is actually an ocean of energy, that floats mass bodies and conceals dark mass bodies. What we can feel is mainly floating mass bodies. The more important part of the universe, the energy bodies and the dark mass bodies is hidden.

### 3. Axiom System of Cosmic Continuum

Below a material axiomatic system of the cosmic continuum will be built as per the cosmic continuum hypothesis, based on Hilbert’s axiomatic vision about physics and with reference to Newtonian mechanics and the axiomatic methods of Euclidean geometry. The axiomatic system of the cosmic continuum is a substantive axiom system [19] [20].

### 3.1. Fundamental Concepts

Term 1: Mass body means an existence composed of particles.

Term 2: Energy body means an existence composed of quanta.

Term 3: Dark mass body means an existence composed of dark particles.

Term 4: Inertia means the existing nature inherent in an existence.

Term 5: Mass is a measure of the inertia of a mass body, express in  $m$ .

Term 6: Energy is a measure of the inertia of an energy body, express in  $E$ .

Term 7: Dark mass is a measure of the inertia of a dark mass body, express in  $D$ .

Term 8: Energy level means the magnitude of the energy of the energy body.

Term 9: Quantum level means the size of the minimum energy of an energy body.

Term 10: Space is the existing dimension of a mass body, its size is represented by  $s$ .

Term 11: Time is the existing dimension of an energy body, its size is represented by  $t$ .

Term 12: Dark space is the existing dimension of a dark mass body, its size is represented by  $g$ .

Term 13: Movement means a process of the spatial location changes of an existence.

Term 14: Displacement means the magnitude of the location change of an existence in space, time and dark space, respectively, with  $\Delta s$ ,  $\Delta t$ ,  $\Delta g$  to represent.

Term 15: Speed means the magnitude of the spatial location change of an existence within a time unit, denoted by  $v$ , whose derivative expression is  $v = ds/dt$ .

Term 16: Acceleration means the magnitude of a speed change of an existence within a time unit, denoted by  $a$ , whose derivative expression is  $a = dv/dt$ .

Term 17: Frequency means the number of times of cyclical change of an existence within a time unit, denoted by  $\nu$ ,  $\nu = 1/T$ ,  $T$  is the cycle.

Term 18: Reaction means the magnitude of the location change in dark space of an existence within a time unit, denoted by  $r$ , whose derivative expression is  $r = dg/dt$ .

Term 19: Increase reaction means the magnitude of the reaction change of an existence within a time unit, denoted by  $i$ , whose derivative expression is  $i = dr/dt$ .

According to the cosmic continuum hypothesis, the particle, quantum and dark particle are the three basic forms of existence, and therefore, they are taken as the original concepts in this axiom system not otherwise defined, their concept was agreed by the discussion about Cosmic continuum hypothesis.

### 3.2. Axioms

The three-dimensional Cartesian coordinate system is employed for the space

dimension in this axiom system, and Euclidean geometry axiom system is also applicable and an isolated system refers to a system without energy exchange with the outside world. 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. The following five axioms are actually the axiomatic statements of the cosmic continuum hypothesis.

**Axiom 1 (Boundary axiom):** There are only three basic forms of existence: particle, quantum, and dark particle. There exists elementary particle  $m_{\min}$ , elementary quantum  $q_{\min}$  and elementary dark particle  $d_{\min}$ . Let  $m_i$ ,  $q_i$ , and  $d_i$  be particles, quantum and dark particles in a cosmic system A, respectively  $m_i \geq m_{\min}$ ,  $q_i \geq q_{\min}$ ,  $d_i \geq d_{\min}$ ,  $i = 1, 2, 3, \dots$

**Axiom 2 (Inertia axiom):** In a cosmic system A, the elementary particle, elementary quantum and elementary dark particle have equivalent inertia size:  $m_{\min} \equiv q_{\min} \equiv d_{\min}$ . “ $\equiv$ ” is the “equivalent” symbol.

**Axiom 3 (Conservation axiom):** The existences in an isolated system keep the total quantity of existences unchanged. Set A is an isolated system, then  $m_1 + E_1 + D_1 \equiv m_2 + E_2 + D_2$ .  $m_1$ ,  $E_1$ ,  $d_1$  and  $m_2$ ,  $E_2$ ,  $d_2$  the size of system mass, energy, dark mass, respectively in time  $t_1$ ,  $t_2$ .

**Axiom 4 (Couple axiom):** 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 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 5 (Variation axiom):** The change of energy is the cause of all cosmic system state changes. Let the change of energy occurring in a system of the universe be  $\Delta E$ , and the corresponding change in the state of the system of the universe be  $\Delta x$ , then  $\Delta E \equiv \Delta x$ .

### 3.3. Fundamental Theorems

**Theorem 1 (Elementary existence theorem):** The existence quantity has its elementary unit  $e_{\min}$ .

Proof: According to Axiom 1 (boundary axiom) there exists an elementary particle  $m_{\min}$ , elementary quantum  $q_{\min}$  and elementary dark particle  $d_{\min}$ , and per Axiom 2 (inertia axiom) the elementary particle, elementary quantum and elementary dark particle have equivalent inertia size:  $m_{\min} \equiv q_{\min} \equiv d_{\min}$ . There exists the elementary unit of the existence  $e_{\min}$ , and the existence quantities of minimum mass, minimum energy and minimum dark mass are the same:  $e_{\min} \equiv m_{\min} \equiv q_{\min} \equiv d_{\min}$ . Q.E.D.

The elementary unit of existence revealed by this theorem is similar to the strings in string theory. The elementary unit has elementary particles, elementary quantum, elementary dark particles in three forms, and all existence consists of these elementary units.

**Theorem 2 (Elementary dimension quantity theorem):** 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  $g_{\min}$  are equivalent.

Proof: A dimension quantity is a measure of the existing dimension of an existence. Therefore, according to Theorem 1 (elementary existence theorem), the existence quantity has its elementary unit  $e_{\min}$ . Corresponding to the basic unit of the existence of the body, there are also basic units of dimension. Because  $e_{\min} \equiv m_{\min} \equiv q_{\min} \equiv d_{\min}$ , so  $w_{\min} \equiv s_{\min} \equiv t_{\min} \equiv g_{\min}$ . Q.E.D.

The above two theorems reflect the essence of quantum mechanics. Since the theoretical presupposition of quantum mechanics is energy quantization, these two theorems indicate that all the existences and their existing dimension are quantized.

**Theorem 3 (Maximum speed theorem):** An existence has a maximum speed and the speed of an energy body is the maximum speed.

Proof: According to Axiom 5 (variation axiom), the change of energy is the cause of all cosmic system state changes, there is no existence that has a speed exceeding that of an energy body unless its acceleration is not driven by the change of energy. Therefore, the speed of an energy body is a maximum one and an existence has its maximum speed. Q.E.D.

This theorem proves that the speed of light  $c$  is insurmountable.

**Theorem 4 (Maximum frequency theorem):** An existence has a maximum frequency  $\nu_{\max}$ .

Proof: According to Theorem 2 (elementary dimension quantity theorem), if there exists a minimum time quantity, and it is represented by  $t_{\min}$ , let  $T$  cycle, then  $T \geq t_{\min}$ . So the maximum value of the frequency  $\nu_{\max} = 1/t_{\min}$ . Q.E.D.

**Theorem 5 (Maximum reaction theorem):** There exists a maximum reaction for an existence and the reaction of an energy body is considered to be the maximum reaction.

Proof: According to Axiom 5 (variation axiom), the change of energy is the cause of all cosmic system state changes. There is no existence that has a reaction exceeding that of an energy body unless its increase reaction is not driven by the change of energy. Therefore, the reaction of an energy body is a maximum one and an existence has its maximum reaction. Q.E.D.

This theorem shows that “quantum entanglement” is actually the reaction of the existence states of particles, quantum, and dark particles driven by changes in energy. Just as the speed of photon is the maximum speed, the photon reaction is also the maximum reaction. In other words, the quantum entanglement speed of photon is also the maximum speed.

**Theorem 6 (Space-time equivalence theorem):** 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: Suppose minimum space quantity is  $s_{\min} = 1/k$  km, then according to Theorem 3 (Maximum speed theorem),  $kc$  ( $s_{\min}/s$ ) is the ceiling speed and no

change can occur within  $1/(kc)$  seconds, otherwise it will go beyond the ceiling speed. That is,  $1/(kc)$  seconds is the minimum time quantity, represented by  $t_{\min}$ . According to Theorem 2 (Elementary dimension quantity theorem),  $s_{\min} \equiv t_{\min}$ , that is,  $1/km \equiv 1/(kc)$  s, also  $1 \text{ s} \equiv c \text{ km}$ . Q.E.D.

**Theorem 7 (Basic transformation theorem):** When the particle reaches its maximum speed, it will be converted to a quantum; When the quantum speed is less than the maximum speed, it will be converted into particle or dark particle; When the quantum reaction is less than the maximum reaction, it will be converted into particle or dark particle; when the particle or quantum reaches its maximum frequency, it will be transformed into dark particle; further when the dark particle reaches its maximum reaction, it will be converted to a quantum.

Proof: According to Theorem 3 (Maximum speed theorem), only the energy body can reach maximum speed, therefore, a particle has to be transformed into a quantum to reach its maximum speed. According to Theorem 3 (Maximum Speed Theorem), the speed of a quantum is a maximum speed. When it is less than a maximum speed, it is no longer a quantum, and if it is not a quantum, it may only be a particle or a dark particle. According to Theorem 5 (Maximum reaction theorem), the reaction of a quantum is a maximum reaction. When it is less than a maximum reaction, it is no longer a quantum, and if it is not a quantum, it may only be a particle or a dark particle. When the frequency of a particle or a quantum reach their maximum value, according to Axiom 1 (Boundary axiom) and Theorem 2 (Basic dimension quantity theorem), only then is the particle or quantum transformed into dark particle, the time can be shielded within the minimum time quantity. Where the reaction of dark particle reaches its maximum value, according to Theorem 5 (Maximum reaction theorem), only the energy body's reaction can reach its maximum value, so only if the dark particle is transformed into a quantum can the reaction reach its maximum value. Q.E.D.

This theorem only discusses the basic transformation between particles, quantum, and dark particles. In fact, there are still many such transformations in the universe. For example, after collision between positive and negative particles, they are "annihilated" as energy quantum, and its inverse process, energy quantum is in certain under conditions, it turns into positive and negative particles with mass, and so on.

**Theorem 8 (Force nature theorem):** Force means the action arising from the location change in space, time and dark space of an existence caused by the change in energy. its size is:  $f_s = dE_s/ds$ ,  $f_t = dE_t/dt$ ,  $f_g = dE_g/dg$ , and the direction of force is that of the change of energy, where  $f_s$  the force for the space dimension,  $f_t$  the force for the time dimension,  $f_g$  the force for the dark space dimension;  $E_s$  the energy that acting on the space dimension,  $E_t$  the energy that acting on the time dimension,  $E_g$  the energy that acting on the dark space dimension.

Proof: According to Axiom 5 (variation axiom), the change of energy is the cause of all cosmic system state changes, set  $\Delta E_s$  indicates the energy change in



the space dimension,  $\Delta E_t$  the energy change in the time dimension,  $\Delta E_g$  the energy change in the dark space dimension,  $\Delta s$  the space displacement,  $\Delta t$  the time displacement and  $\Delta g$  the dark space displacement, then the more the energy changes, the greater the force acts on the existence, *i.e.*  $f_s$ ,  $f_t$ ,  $f_g$  is proportional to  $\Delta E_s$ ,  $\Delta E_t$ ,  $\Delta E_g$ , respectively; and the more change of the existence in space, time or dark space caused by the energy change, the greater the action of energy change is broken down, the smaller the force acting on the existence, *i.e.*  $f_s$ ,  $f_t$ ,  $f_g$  is inversely proportional to  $\Delta s$ ,  $\Delta t$ ,  $\Delta g$ , respectively. so  $f_s = \lim_{\Delta s \rightarrow 0} \Delta E_s / \Delta s = dE_s / ds$ ,  $f_t = \lim_{\Delta t \rightarrow 0} \Delta E_t / \Delta t = dE_t / dt$ ,  $f_g = \lim_{\Delta g \rightarrow 0} \Delta E_g / \Delta g = dE_g / dg$ . Since the force arises from the change in energy, the direction of the force is the very direction of the energy change. Q.E.D.

$f_s = dE_s / ds$  is the force effect of the existence in the space dimension, reflecting the essence of classical mechanics;  $f_s = dE_s / ds$ ,  $f_t = dE_t / dt$  is the force effect of the existence in the space and time dimension, reflecting the essence of relativistic mechanics;  $f_g = dE_g / dg$  is the force effect of the existence in the dark space dimension, which is the expansion of the concept of force.

“Force nature theorem” further reflects the essence of the “equivalence principle” of general relativity as the acceleration of gravity in a gravitational field and the acceleration in a reference system, both reflect the change of the movement speed. The essence of such change is energy change. Therefore, when the movement in a non-inertial reference system is considered, the “equivalence principle” of general relativity would be applicable: the gravitational field is equivalent to the reference frame moving at an appropriate acceleration.

**Theorem 9 (First theorem of motion):** An existence will remain, with its existing motion status unchanged, when no change occurs in the energy.

Proof: According to Axiom 5 (variation axiom), the change of energy is the cause of all cosmic system state changes. Let  $\Delta E$  is the energy change in a universe system,  $\Delta v$  is the change of movement state in the universe system, then  $\Delta E \equiv \Delta v$ , if  $\Delta E = 0$ , then  $\Delta v = 0$ . If no energy change occurs to an existence, no motion change will occur either, and therefore, the existence will keep its existing motion state. Q.E.D.

**Theorem 10 (Second theorem of motion):** An existence will change its original motion state if the energy changes.

Proof: According to Axiom 5 (variation axiom), the change of energy is the cause of all cosmic system state changes. Let  $\Delta E$  is the energy change in a universe system,  $\Delta v$  is the change of movement state in the universe system, then  $\Delta E \equiv \Delta v$ , if  $\Delta E \neq 0$ , then  $\Delta v \neq 0$ . If an energy change occurs to an existence, motion state change also will occur, and therefore, the existence will change its existing motion state. Q.E.D.

**Theorem 11 (Third theorem of motion):** When two existences experience an energy exchange and there is no conversion the amount of existences, the energy change between the two existences are in an equal:  $\Delta E_1 = \Delta E_2$ , and opposite direction.

Proof: Two existences can be seen as an isolated system A. According to Axiom 3

(conservation axiom), if A is an isolated system, then  $m_1 + E_1 + D_1 \equiv m_2 + E_2 + D_2$ .  $m_1, E_1, d_1$  and  $m_2, E_2, d_2$  the size of system mass, energy, dark mass, respectively in time  $t_1, t_2$ . the total amount of existences never changes when two existences are exchanging energy, and further, since no conversion of existences occurs within an isolated system, the total amount of energy within the system remains unchanged. In order to keep the total amount of energy unchanged, the change in the energy of one existing entity and the change of the energy of another existing entity must offset each other, that is, equal in size:  $\Delta E_1 = \Delta E_2$ , and in the opposite direction. Q.E.D.

The above three theorems of motion reveal the essence of Newton's three laws of motion. In the case of mass body movement, the energy change is the change in the movement states, and the said three theorems can be stated as Newton's three laws of motion. Acceleration then will be generated due to the change of speed caused by the energy change of the mass body. Force is the cause of the acceleration generated in the mass body:  $f = ma$ , where  $m$  is the mass of the mass body and  $a$  is the acceleration. So Newton's three laws of motion are the corollary of this axiom system from which the conclusions of classical mechanics can be deduced.

**Theorem 12 (Time displacement theorem):** When the existence  $z$  moves at a speed  $v$ , the time displacement is  $\Delta t = t_0 - t$ , where,  $t = t_0 \sqrt{1 - v^2/c^2}$ .  $t$  is the time experienced by the existence and  $t_0$  is the observed movement of time.

Proof: Suppose the existence within  $\Delta t = t_0 - t$  moves at a speed  $v$  within a time  $t$ , the observed movement time is  $t_0$  and the space displacement is  $s$ . According to Axiom 5 (variation axiom), the change of energy is the cause of all cosmic system state changes. According to the equation of kinetic energy:  $E = zv^2/2 = zs^2/(2t_0^2)$ , energy change of an existence during movement is proportional to  $v^2$  and inversely proportional to  $t_0^2$ . Due to the fact that time displacement is actually related to the energy change, when the existence is motionless, the time displacement will be zero, and the time experienced by the existence is the same as the observed movement of time. That is, where  $v^2 = 0$ , then  $t^2 = t_0^2$ . When the speed reaches the maximum value  $c$ , the energy change is maximized and the time displacement is equivalent to the overserved time as the time taken is related to the energy change. Therefore,  $\Delta t = t_0 - t = t_0$ , that is  $t = 0$ . That means, when  $v^2 = c^2$ , then  $t^2 = 0$ . Accordingly, two vectors,  $(0, t_0^2)$  and  $(c^2, 0)$ , are obtained according to the linear relationship with the vector  $(v^2, t^2)$ , then  $t = t_0 \sqrt{1 - v^2/c^2}$ . So the time displacement of an existence is obtained:  $\Delta t = t_0 - t$ . Q.E.D.

This theorem reveals the substance of a "time dilation effect" and the "relativity of simultaneity" in the motion of relativity. The "Time displacement theorem" indicates that the time experienced by an existence, that is motionless relative to a reference frame, is equal to the observed time. While the existence moves, a certain time will be occupied, that is, "time displacement" occurs. For example, the light emitted by a planet one-light year away from Earth, taking a year to reach the Earth, refers to the time of the observed light movement as one

year by taking the Earth as the reference frame. While light traveling at extreme velocity occupies all time, that is, in this example, a time displacement of one year, therefore, the time elapsed by the light itself is zero.

**Theorem 13 (Mass-energy equivalence theorem):** The existence quantities of mass  $m$  and energy  $E = mc^2$  are equivalent:  $m \equiv E$ .

Proof: According to Theorem 3 (Maximum speed theorem) and Theorem 7 (Basic transformation theorem), the calculation of energy equivalence of the mass  $m$  is equivalent to that of the value of energy change of the mass body  $m$  when moving at ceiling speed  $c$ . When the speed of the mass body  $m$  is  $c$ , the kinetic energy during movement is  $E_s = mc^2/2$ . According to Theorem 12 (Time displacement theorem), when the mass body  $m$  moves at speed  $c$ , the time displacement is equal to the observed time  $t_0$ , and according to Theorem 6 (Space-time equivalence theorem), the time displacement is equivalent to the space displacement of the mass body  $m$  at  $t_0c$ . This indicates that the energy change  $E_t$  in the time dimension is equal to the energy change  $E_s$  in the space dimension. Provided the total energy change of the mass body  $m$  is  $\Delta E$ , then  $\Delta E = E_s + E_t = 2E_s = mc^2$ . Therefore,  $m \equiv E$ . Q.E.D.

This theorem reflects the relativistic “mass-energy relationship” in substance. Relativity believes existences experience “mass defect”, the loss is actually the nuclear binding energy. Einstein’s introduction of the “rest mass” and the concept of “mass-energy relation” makes a reasonable explanation.

**Theorem 14 (Structural stability theorem):** The stability of the structure of existence is determined by the quantum level used for coupling the existence, and the higher the quantum level is, the more stable the structure.

Proof: According to Axiom 4 (coupling axiom), 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 amount of existence, the corresponding structure of the particle  $m$ , dark particle  $d$  is also the amount of  $e$ :  $m \equiv d \equiv q \equiv e$ . According to Axiom 5 (variation axiom), the change of energy is the cause of all cosmic system state changes, so the higher the quantum level used for coupling the existence, the stronger the resistance towards the action of the external energy change, and therefore the more stable the structure. Q.E.D.

According to Theorem 14 (Structural stability theorem), the mechanism of the photoelectric effect and the nuclear reaction can be explained totally. The reason for the photoelectric effect is as follows: when a photon is greater than the coupling energy quantum between electrons and the nuclei, the coupling structural between the electrons and nuclei will be destroyed, thereby producing the electron escape phenomena. Actually, the magnitude of the work function  $W$  shown by Einstein’s photoelectric effect formula, is the magnitude of the coupling energy quantum between electrons and nuclei. Similarly, the nuclear reaction is due to the destruction of the atomic nucleus structure by exotic quantum.

Axiom 4 (coupling axiom) also reveals the nature of the wave-particle duality of the light, that is, the light wave is formed by the quantum of the coupling energy of the photon. The photon will form the junction structure with the motion direction as the axis, Resulting in a transverse light wave.

**Theorem 15 (Elementary coupling theorem):** The coupling energy of the elementary coupling between the existing bodies is composed of elementary quantum.

Proof: According to Axiom 4 (coupling axiom), the existences are coupled with energy. Energy can be composed by quanta of different order of magnitudes. According to Theorem 14 (Structural stability theorem), a high order of energy can destroy the structure of an existence coupled with a low order of energy. On the contrary, the energy of a low order of magnitude cannot destroy the structure of the existence coupled with a high order of energy. If the elementary coupling energy between the existing bodies is not composed of an elementary quantum, but composed of a quantum greater than an elementary quantum, then, the coupling structure of the elementary particle  $m_{\min}$ , elementary quantum  $q_{\min}$  and elementary dark particle  $d_{\min}$  will be destroyed. This shows that only coupling energy composed of an elementary quantum can become the elementary coupling energy between the existing bodies. Therefore, the elementary coupling energy between the existing bodies is composed of elementary quantum. Q.E.D.

The elementary coupling energy between the existing bodies is exactly what Einstein predicted with gravitational waves, because only gravitational waves are common in all existing bodies, including the elementary particle  $m_{\min}$ , elementary quantum  $q_{\min}$ , and elementary dark particle  $d_{\min}$ . This elementary coupling energy cannot be detected by any method, because it consists of elementary quantum  $q_{\min}$  and that is not enough to destroy any coupling structure. Moreover, any detective devices and gravitational waves are also coupled by elementary coupling energy. This is the reason why Einstein's predicted gravitational waves could not be detected for more than a century. The coupling energy of the elementary coupling between the existing bodies is the so-called dark energy we cannot find, the energy ocean that fills the whole universe.

**Theorem 16 (Permanent center theorem):** The center coordinate of an isolated system remains unchanged.

Proof: According to Axiom 5 (variation axiom), the change of energy is the cause of all cosmic system state changes, as there is no action of external energy, no energy change occurs inside an isolated system, and therefore, the integrity of the system will not be destroyed, and the center coordinates will remain unchanged. Q.E.D.

The above theorems are the basic conclusions of classical mechanics, quantum theory and relativity and are mainly derived from the axiom system, and to make reasonable explanations for dark mass, dark energy, quantum entanglement, etc., which reflects the heritage and unity of scientific theory.

## 4. Axiom System of Action at a Distance

The axiom system of action at a distance is a sub-system built based upon the axiom system of the cosmic continuum. Accordingly, the fundamental concepts and axioms from the axiom system of the cosmic continuum can be taken as the general concepts and axioms of the axiom system of action at a distance. The axiom system of the cosmic continuum is the basic theory of force, the axiom system of action at a distance is the basic theory of the field and both constitute the basic theoretical system of physics.

The action at a distance in this axiom system refers to the interaction between the existences that never contact each other. According to the “coupling axiom”, the existences are coupled with energy, which means that each entity has a coupling energy system. According to the “variation axiom”, the change of energy is the cause of all cosmic system state changes. Therefore, the so-called action at a distance can be regarded as the interaction between the coupling energy, the direction of action is determined by the direction of the coupling energy changes.

### 4.1. Fundamental Concepts

Term 1: Action at a distance means the interaction between the existences that never contact each other.

Term 2: Field means the coupling energy system of an existence generating action at a distance.

Term 3: Field level means the ability of an existence, via its field, to act on the field of other existences, its size is represented by  $E_r$ .

Term 4: Initial field means the field formed by an existence in its static state.

Term 5: Affiliated field means a new field generated from the change of the structure of the field caused by the movement of the existence. The affiliated field of the initial field is called the first hierarchy affiliated field. The affiliated field of the first hierarchy affiliated field is called the second hierarchy affiliated field, and so on ad infinitum.

Term 6: Unified field means the infinite-hierarchy field of an existence that is composed of the initial and affiliated fields.

### 4.2. Axioms

**Axiom 1 (Direct proportion of existence amount axiom):** The field level  $E_r$  of the field of the existence  $Z$  is proportional to the amount  $Z$  of the existence:  $E_r \sim Z$ .

**Axiom 2 (Inverse proportion of distance axiom):** The field level  $E_r$  of the field of the existence  $Z$  is inversely proportional to the distance  $r$  between the existence and the point of action:  $E_r \sim 1/r$ .

**Axiom 3 (Direct proportion of vertical speed axiom):** The field level  $E_r$  of the affiliated field of the existence  $Z$  is proportional to the component of the speed  $v$  in the vertical direction of the energy change of its superior hierarchy

field:  $E_r \sim v \sin \theta$ ,  $\theta$  is the angle between the direction of movement and the action direction of its superior hierarchy field.

**Axiom 4 (Direct proportion of field level axiom):** When two existences  $Z_1$  and  $Z_2$  interact with each other via their fields, the forces acting on each is proportional to the location  $E_r$  and  $E'_r$  of the two existences in the field of the other part:  $f \sim E_r E'_r$ .

**Axiom 5 (Center diverging direction axiom):** The energy change diverges outwards, centering at an existence when the initial field acts on another field.

**Axiom 6 (Vertical movement direction axiom):** The energy change diverges outwards vertically by taking the movement direction as the axis when the affiliated field acts on another field.

**Axiom 7 (Fore field vertical direction axiom):** The energy change diverges outwards vertically by taking the energy change direction of its superior hierarchy field as the axis when the affiliated field acts on another field.

### 4.3. Fundamental Theorems

**Theorem 1 (Field level of initial field theorem):** The field level of the initial field of the existence  $Z$  at a certain point of action is  $E_r \sim Z/r$ , where,  $r$  indicates the distance of  $Z$  to the point of action.

Proof: The field level of an initial field refers to the ability of an existence to act on another field via its field when such an existence is motionless relative to the stationary reference system. A coordinate system is established by taking the existence  $Z$  as the origin. The field level, according to Axiom 1 (direct proportion of the existence amount axiom), is proportional to the existence  $Z$ . According to Axiom 2 (inverse proportion of distance axiom), it is inversely proportional to the distance  $r$  between the existence  $Z$  to the point of action, therefore,  $E_r \sim Z/r$ . Q.E.D.

**Theorem 2 (Initial field action direction theorem):** The action direction of the initial field of the existence  $Z$  is along the line connecting  $Z$  and the point of action.

Proof: Since the initial field of the existence  $Z$  is a field formed when the existence  $Z$  is motionless relative to the reference system, a coordinate system is established by taking the existence  $Z$  as the origin. According to axiom 5 (center diverging direction axiom), the energy change diverges outwards centering at an existence, so the action direction is along the line connecting  $Z$  and the point of action. Q.E.D.

**Theorem 3 (Initial field-to-initial field action direction theorem):** The action direction of the initial fields of two existences  $Z_1$  and  $Z_2$  is along the line connecting  $Z_1$  and  $Z_2$ .

Proof: A coordinate system with the existence  $Z_1$  or  $Z_2$  as the origin is established. According to Theorem 2 (Initial field action direction theorem), the action direction of the initial field of  $Z_1$  is along the line connecting  $Z_1$  and  $Z_2$ , and the action direction of the initial fields of  $Z_2$  is along the line connecting  $Z_2$  and

$Z_1$ . The action direction of the initial field of  $Z_1$  and  $Z_2$  is along the line connecting  $Z_1$  and  $Z_2$ . Q.E.D.

**Theorem 4 (Initial field-to-initial field action theorem):** 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: A coordinate system with the existence  $Z_1$  or  $Z_2$  as the origin is established. According to Theorem 1 (Field level of the initial field theorem), the field level of the initial fields of  $Z_1$  and  $Z_2$  is  $E_r \sim Z_1 / r$  and  $E'_r \sim Z_2 / r$ , respectively. According to Axiom 4 (direct proportion of field level axiom), the interaction force  $f$  is proportional to  $E_r$  and  $E'_r$ :  $f \sim E_r E'_r \sim Z_1 Z_2 / r^2$ . According to Theorem 2 (Initial field-to-initial field action direction theorem), the action direction is along the line connecting  $Z_1$  and  $Z_2$ . Q.E.D.

Theorem 4 reflects the essence of the law of universal gravitation and Coulomb's law. When the existence is a mass body, the theorem is the law of universal gravitation; when the existence is an electron, the theorem is Coulomb's law.

**Theorem 5 (Field level of an affiliated field theorem):** The field level of the affiliated field generated when the existence  $Z$  moves at speed  $v$  is:  $E_r \sim Z v \sin \theta / r$ , where,  $r$  is the distance between  $Z$  and the point of action,  $\theta$  is the angle between the direction of movement and the action direction of its superior hierarchy field.

Proof: A coordinate system with the initial location of the movement of the existence  $Z$  as the origin is established. The field level  $E_r$  of the affiliated field, according to Axiom 1 (Direct proportion of an existence amount axiom), is proportional to the existence  $Z$ . According to Axiom 3 (Direct proportion of vertical speed axiom),  $E_r$  is proportional to the component  $v \sin \theta$  of the speed  $v$  at the vertical direction of the action of the superior hierarchy field. According to Axiom 2 (inverse proportion of distance axiom),  $E_r$  is inversely proportional to the distance  $r$  between  $Z$  and the point of action, then  $E_r \sim Z v \sin \theta / r$ . Q.E.D.

**Theorem 6 (Initial field-to-affiliated field action direction theorem):** The direction of the action of the initial field of the existence  $Z_1$  on the affiliated field of the existence  $Z_2$  is on the plane determined by the line connecting  $Z_1$  and  $Z_2$  and the movement direction of  $Z_2$  or the action direction of the affiliated field of the superior hierarchy field, and perpendicular to the movement direction of  $Z_2$  or the action direction of the affiliated field of the superior hierarchy field.

Proof: As the initial field is a field formed when the existence is motionless, a coordinate system taking the existence  $Z_1$  as the origin is established. Since the existence  $Z_2$  is moving, for the first hierarchy affiliated field, according to Axiom 6 (vertical movement direction axiom), the energy change diverges outwards vertically by taking the movement direction of  $Z_2$  as the axis, and the action direction is perpendicular to the movement direction of  $Z_2$ . For the affiliated field above the second hierarchy, according to Axiom 7 (fore field vertical direction axiom), the energy change diverges outwards vertically by taking the direction of

the energy change of its superior hierarchy field as the axis, and the action direction is perpendicular to that of the superior hierarchy field. Further, according to Axiom 5 (center diverging direction axiom), the energy change of the initial field of  $Z_1$  diverges outwards centering at  $Z_1$ , and the action direction is on the plane determined by the line connecting  $Z_1$  and  $Z_2$  and the movement direction of  $Z_2$  or the action direction of the affiliated field of the superior hierarchy field. Therefore, the direction of the action of the initial field of  $Z_1$  on the affiliated field of  $Z_2$  is on the plane determined by the line connecting  $Z_1$  and  $Z_2$  and the movement direction of  $Z_2$ , and perpendicular to the movement direction of  $Z_2$  or the action direction of the affiliated field of the superior hierarchy field. Q.E.D.

**Theorem 7 (Initial field-to-affiliated field action theorem):** The action force of the initial field of existence  $Z_1$  on the affiliated field of existence  $Z_2$  is:  $f \sim Z_1 Z_2 v_2 \sin \theta_2 / r^2$ . The direction of the action is on the plane determined by the line connecting  $Z_1$  and  $Z_2$  and the movement direction of  $Z_2$  or the action direction of the affiliated field of the superior hierarchy field, and is perpendicular to the movement direction of  $Z_2$  or the action direction of the affiliated field of the superior hierarchy field, where,  $v_2$  indicates the movement speed of  $Z_2$ ,  $\theta_2$  the angle between the movement direction of  $Z_2$  and the action direction of the superior hierarchy field, and  $r$  is the distance between  $Z_1$  and  $Z_2$ .

Proof: As the initial field is a field formed when the existence is motionless, a coordinate system taking the existence  $Z_1$  as the origin is established. According to Theorem 1 (Field level of the initial field theorem), the field level of the initial field of  $Z_1$  is  $E_r \sim Z_1 / r$ , and according to Theorem 5 (Field level of the affiliated field theorem), the field level of the affiliated field of  $Z_2$  is  $E'_r \sim Z_2 v_2 \sin \theta_2 / r$ . According to Theorem 4 (Initial field-to-initial field action theorem), the interaction force  $f$  is proportional to the field level  $E_r$  and  $E'_r$  in the field of the other existence:  $f \sim E_r E'_r \sim Z_1 Z_2 v_2 \sin \theta_2 / r^2$ . According to Theorem 6 (Initial field-to-affiliated field action direction theorem), the direction of the action is on the plane determined by the line connecting  $Z_1$  and  $Z_2$ . The movement direction of  $Z_2$ , or the action direction of the affiliated field of the superior hierarchy field, and perpendicular to the movement direction of  $Z_2$  or the action direction of the affiliated field of the superior hierarchy field. Q.E.D.

**Theorem 8 (Affiliated field-to-affiliated field action direction theorem):** The direction of the action of the affiliated field of existence  $Z_1$  on the affiliated field of existence  $Z_2$  is perpendicular to the plane determined by the action direction of the superior hierarchy field of  $Z_1$  and the movement direction of  $Z_2$  or the action direction of the superior hierarchy field.

Proof: A coordinate system is established with the initial location of the movement of existence  $Z_1$  as the origin. According to Axiom 7 (fore field vertical direction axiom), the energy change diverges outward vertically by taking the action direction of its superior hierarchy field as the axis when the affiliated field of  $Z_1$  acts on another field. The action direction is perpendicular to that of the superior hierarchy field of  $Z_1$ . As the force acts on existence  $Z_2$  and existence  $Z_2$  is moving, for the first hierarchy affiliated field, according to Axiom 6 (Vertical



movement direction axiom), the energy change diverges outward vertically by taking the movement direction of  $Z_2$  as the axis. The action direction is perpendicular to the movement direction of  $Z_2$ . For the affiliated field above the second hierarchy, according to Axiom 7 (fore field vertical direction axiom), the energy change diverges outward vertically by taking the direction of energy change of its superior hierarchy field as the axis, and the action direction is perpendicular to that of the superior hierarchy field. Therefore, the direction of the action of the affiliated field of  $Z_1$  on the affiliated field of  $Z_2$  is on the plane determined by the action direction of the superior hierarchy field of  $Z_1$  and the movement direction of  $Z_2$ , and is perpendicular to the movement direction of  $Z_2$  or the action direction of the affiliated field of its superior hierarchy field. Q.E.D.

**Theorem 9 (Affiliated field-to-affiliated field action theorem):** The two existences,  $Z_1$  and  $Z_2$ , are moving at speed  $v_1$  and  $v_2$ , respectively. The action force of the affiliated field of existence  $Z_1$  on the affiliated field of existence  $Z_2$  is:  $f \sim Z_1 Z_2 v_1 v_2 \sin \theta_1 \sin \theta_2 / r^2$ . The direction of action is on the plane determined by the action direction of the superior hierarchy field of  $Z_1$  and the movement direction of  $Z_2$  or the action direction of the superior hierarchy field.  $\theta_1$  and  $\theta_2$  indicate the angles between the movement direction of  $Z_1$  and the action direction of the superior hierarchy field of  $Z_1$ , and the movement direction of  $Z_2$  and the action direction of the superior hierarchy field of  $Z_2$ , respectively.  $r$  is the distance between  $Z_1$  and  $Z_2$ .

Proof: According to Theorem 5 (Field level of the affiliated field theorem), the field level of the affiliated field of  $Z_1$  is  $E_r \sim Z_1 v_1 \sin \theta_1 / r$ , and that of the affiliated field of  $Z_2$  is  $E'_r \sim Z_2 v_2 \sin \theta_2 / r$ . According to Axiom 4 (direct proportion of field level axiom), the action force of the affiliated field of  $Z_1$  on that of  $Z_2$  is proportional to  $E_r$  and  $E'_r$ :  $f \sim E_r E'_r \sim Z_1 Z_2 v_1 v_2 \sin \theta_1 \sin \theta_2 / r^2$ . According to Theorem 8 (Affiliated field-to-affiliated field action direction theorem), the action force of the affiliated field of  $Z_1$  on that of  $Z_2$  is perpendicular to the plane determined by the action direction of the superior hierarchy field of  $Z_1$  and the movement direction of  $Z_2$  or the action direction of the affiliated field of the superior hierarchy field. Q.E.D.

$f \sim ZZ'v \sin \theta / r^2$  and  $f \sim Z_1 Z_2 v_1 v_2 \sin \theta_1 \sin \theta_2 / r^2$  are the mathematical expressions of the familiar Lorentz force. It is not difficult to find that the role of the electric field strength  $E$  and the magnetic field strength  $H$  in existing electromagnetic theory is similar to field level  $E_r$ . Indicating power with  $q$ , the electric field level with  $E_r$ , the magnetic field level with  $E'_r$ , and the distance  $r$ , the relational expressions between the electric field strength  $E$  and the electric field level  $E_r$  are obtained:  $E = q / r^2 \sim E_r / r$  or  $E_r \sim E \cdot r$ , and the relational expressions between the magnetic field strength  $H$  and the magnetic field level are also obtained:  $H = qv \sin \theta / r^2 \sim E'_r / r$  or  $E'_r \sim H \cdot r$ . Therefore, the above theorems reveal the essence of the electromagnetic field.

**Theorem 10 (Unified field action theorem):** The interaction between the unified fields of two existences is determined by the interaction between the initial fields and infinite-hierarchy affiliated fields. The energy changes in the two

existences during the interaction in the unified field are equal and the directions of energy changes are opposite.

**Proof:** The unified field is a field consisting of an initial field and infinite hierarchy affiliated fields, therefore, the interaction force between the unified fields are the total interaction of forces between their initial fields and their infinite-hierarchy affiliated fields. Since the unified fields of two existences can be taken as an isolated system during the interaction, the energy exchange between two unified fields does not change the total energy of the system. In other words, the energy changes of the two unified fields are equal and the directions of energy change are opposite. Q.E.D.

**Theorem 11 (Inaccurate solution theorem):** The unified field model of action, from a distance between existences, only has an approximate solution rather than an exact solution.

**Proof:** The unified field model has an infinite hierarchy, so there is no solution; yet the approximate model of a finite hierarchy of the unified field is solvable, so the unified field model has no exact solution. Q.E.D.

The above fundamental theorem mainly discusses the interaction between two fields. Furthermore, the interaction between pluralities of fields can also be deduced in this axiom system [19] [20].

## 5. Application Example

Below Hilbert's sixth problem solution proposed in this paper is applied in solving the problem of "deflection of light" under the action of gravity [21].

A coordinate system, taking the sun as the origin, is established. Suppose the direction of a light ray is the  $y$  axis, and the direction perpendicular to the light ray is the  $x$  axis, the speed of light  $c$ , photon energy  $e$ , mass of the sun  $M$ , distance from the photon to the sun  $r$ , angle between the  $x$  axis and the line connecting the photon and the sun  $\theta$  ( $\theta$  and the angle between the  $y$  axis and the line connecting the photon and the sun are complementary angles), gravitational constant  $k$  and vertical distance from the sun to light  $p$ .

According to "mass-energy equivalence theorem",  $e$  can be turned into its equivalent mass  $m$ :

$$m \equiv e/c^2 \quad (1)$$

According to "Initial field-to-affiliated field action theorem", the action force of the initial field of the sun on the first-hierarchy affiliated field of the photon can be obtained, as follows:

$$F = -kMm \cos \theta / r^2 \quad (2)$$

The action direction is on the plane determined by the line connecting the sun and the photon and the light ray, and perpendicular to the direction of light, that is, perpendicular to in the  $x$  axis. In Expression (2), "-" indicates the direction. Further, based on the following relational expression of force and acceleration:

$$F = m \cdot d^2x/dt^2 \quad (3)$$

The acceleration in the  $x$  axis direction of the photon can be obtained, as follows:

$$d^2x/dt^2 = -kM \cos \theta / r^2 \quad (4)$$

Taking  $t$  as the variable integral for Expression (4), the speed of the photon in the  $x$  axis direction is as follows:

$$v_x = -\int_{-\infty}^{\infty} [(kM)/r^2] \cos \theta dt \quad (5)$$

It can be converted into the following expression:

$$v_x = -\int_{-\pi/2}^{\pi/2} [(kM)/(r^2 \dot{\theta})] \cos \theta d\theta \quad (6)$$

If it is known that  $r^2 \dot{\theta}$  is the area constant  $cp$ , then the deflection angle is obtained as follows:

$$\alpha_1 = v_x/c = -2kM/(c^2 p) \quad (7)$$

According to “Initial field-to-initial field action theorem”, the deflection angle generated by the action of the initial field of the sun on that of the photon can be obtained, as follows:

$$\alpha_2 = -2kM/(c^2 p) \quad (8)$$

This is a classic conclusion of the theory of universal gravitation, and “Initial field-to-initial field action theorem” is equivalent to the “law of universal gravitation”, so the derivation is omitted. The total deflection angle is:

$$\alpha = \alpha_1 + \alpha_2 = -4kM/(c^2 p) \quad (9)$$

The conclusion is the same as that solved by applying general relativity. This shows that the essence of “time-space bending” mentioned by relativity is the macroscopic effect of quantum trajectory bending under the action of gravitational field.

## 6. Conclusions

The axiom system of the cosmic continuum is the basic theory about force. The axiom system of the action at distance is the basic theory about fields, and the basic theory of force is fundamental in the basic theory of the field. Using the basic theories of force and field as the basic theory of physics, the entire physics system can be built. The axiomization of the basic theories of force and field makes it possible to solve Hilbert’s sixth problem “The mathematical treatment of the axioms of physics”. The science and feasibility of this study can be guaranteed by the following points:

- 1) The cosmic continuum is a mathematical model of the laws of the universe that are compatible with classical and modern science.
- 2) The cosmic continuum is a mechanics system that can unify classical theory, quantum theory and relativity.
- 3) The axiomatic system of action at distance is a basic system of the field that can unify the electromagnetic field and the gravitational field.

4) The attempt to establish the axiomatic system of action at distance based on the axiomatic system of the cosmic continuum provides an effective path for “axiomization of physics”.

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