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On the Attribution of Mercury's Perihelion Precession

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Abstract

Although Newtonian gravity and general relativity predicted the precession of Mercury perihelion historically, many improved methods continue to predict the precession of Mercury during recent decades of years. Uncertainties in various predictions and observations suggest that the attribution of Mercury's precession is still not well understood. This paper argues that the cause of Mercury's precession is not gravity, but the inertia of material motion left over from the formation of the solar system. According to this inertia theory, the planetary precession is associated with the ratio of total mass-energy density of the system to the mass-energy of the Sun and its change over time. If other factors are not changed with time, the perihelion precession of planets per orbit is proportional to his distance relative to the Sun. The conclusions of this paper can provide more effective factor considerations for the complete description of various astronomical events and phenomena using general relativity equations.

Keywords

Mercury, Perihelion Precession, Attribution, Newtonian Gravity, General Relativity, Inertia of Material Motion

1. Introduction

Mercury is the inner most one of the four terrestrial planets in the solar system. According to Newton's theory, Mercury's orbit should be a closed ellipse, consistent with the results proposed at the beginning of 1600s by Kepler. In fact, Mercury orbits its trajectory in an ellipse, and its long axis also rotates slightly in space. The rotation of the long axis is called precession, also known as perihelion precession. In 1859, French mathematician U. Le Verrier first reported Mer-

cury's perihelion anomalous precession, finding that there was a discrepancy by 38" arcseconds per tropical century between the perihelion precession observations and Newton's law calculations [1]. He attributed that the phenomenon is perturbated by an unknown planet. However, this speculative planet was never discovered. In 1882, Canadian American astronomer and mathematician Simon Newcomb corrected to 43" of a precession difference [2]. For more than half a century, the Mercury precession has been a highly controversial topic, giving rise to many alternative theories [3]. But these theories and calculations are based on the principle of traditional Newtonian mechanics.

As early as 1907, Einstein began to study the theory of gravity, hoping to find a way to calculate the perihelion precession of Mercury. Eight years later, he finally found it. In 1915, Einstein proposed his theory of general relativity which has been experimentally verified with great accuracy for samples of various materials and planets [4] [5]. Einstein's theory predicted correct advance of the perihelion of Mercury [6]. The success of the perihelion precession prediction shows that general relativity is an excellent expression and alternative theory of gravity. Since perihelion precession is a direct derivation of the entire theory of relativity, not just the equivalence principle, Einstein considered it the most critical test of his theory.

Newtonian mechanics differs from general relativity in that the former's gravitational formula has only two factors or parameters of object's mass and their distance, while the latter, in addition to considering the mass factor of multiple objects, is relative to object's rotation and energy as well as other factors. Considering that the effect of rotation causes the precession of rotated axis, the axis of rotation will slowly change during the movement of planets. The Mercury's perihelion moves slightly at the speed of 5600 arcseconds per century, in the same direction in which the planet rotates around the Sun. However, it is not known for the causes of the rotations and revolutions of planets, moons, and stars with different sizes. The rotation of all planets, such as Mercury and Earth, forms their Coriolis forces. The Coriolis force is not a real force, but the inertial motion of matter. This article will first clarify that the force perceived by people is the inertial motion of matter.

Recently, it has been debated whether general relativity can predict the precession of Mercury more accurately than traditional Newtonian mechanics [7]. Also in recent years, various factors that affect the precession of planets are considered, and different predictions of Mercury's precession have been made. One is to consider the three-body or many-body perturbation influence such as the influence of the solar system's planets on the orbit precession of Mercury under the framework of classical mechanics [8] [9], while some even tweaked the theory of gravity to test and predict the precession of planets [10] [11]. The second considers the internal characteristics of the Sun, such as the role of the solar oblateness and the Sun's interior rotation on Mercury's precession [12] [13]. For the prediction of Mercury's precession, various methods such as the equivalence principle of special relativity, linear algorithms of relativity, and model simula-

tion have been used [14] [15] [16], which also yield essentially the same values as other theories. In addition, it has been suggested that there are still uncertainties in the measurement and calculation of Mercury's perihelion precession [17] [18] [19].

The perihelion precession of Mercury is already an astronomically accepted fact. Based on Newton's gravitational theory and Einstein's general relativity, a variety of prediction methods for planetary precession have been developed. Numerous uncertainties from predictions and observations suggest that the attribution of Mercury's precession is still not well understood. Fundamentally, the attribution of Mercury's perihelion precession is not any expression of gravity, or action at a distance. This article first explains in Section 2 that the motion of matter in nature is not the action of gravity, but the inertial motion of matter. Section 3 introduces an inertial theory of orthogonal collisions to form new states of matter. Section 4 uses this theory to explain the attribution of Mercury's precession. Finally, conclusions and discussion are given in Section 5 and Section 6, respectively.

2. The Inertial Motion of Matter in Nature

One visual force that people can perceive is the Earth's rotation deflection force, or the Coriolis force. The longest river in China, the Yangtze River, flows into the alluvial plain of Jiangsu Province, the right side of the river is washed slightly away, and the estuary gradually shifts to the south (right), which is the result of the Coriolis force. This force is not a real force, but the inertial motion of water flow relative to the rotating Earth. Similarly, apples fall freely from trees, natural satellites orbit planets, planets orbit the Sun, and planets and moons rotate, all are their inertial motion. To change their inertial motion, the action of force is required. On the Sun and stars, the relative motion between their inner spheres is also inertial motion. This crossed relative inertial motions and the resulting multiscale vortex motions excite nuclear reactions, colliding to produce high-velocity (high-energy) particles. When the momentum of particles reaches a certain value excited by a star, their inertia will change from the star, and finally the particles seemly escape the gravitational bondage of the star. In fact, it is not the gravitational pull of the star, but the force of the nuclear reaction that changes the inertial motion of particles.

The photons and charged particles are formed by nuclear reactions on the Sun. Nuclear reactions require an environment that transforms old mass and energy into new matter and energy. The purpose of the artificial electron collider is to build opportunities for high-energy particles to collide. Particle collisions can form new states of matter, that is, new particle energies and new inertial motion of matter. We believe that the inertial motion of the Sun's revolution and rotation, and the inertial motion of the Earth's revolution and rotation, were formed by a collision of materials from the formation of the solar system. There were no humans at that time, so we do not know the cause of that collision and every-

thing before it. The inertial motion or potential tendency of matter moving in the current universe, observed by modern human, is visual forces, including rotational deflection such as the Coriolis force and gravity. For the inertial motion of matter (particles) on the Earth and their potential movement tendency, the target is to rotate towards the Earth's center. The inertial motion of matter (particles) in the solar system and their potential movement tendency are to rotate towards the Sun's center. The inertial motion of matter (particles) and their potential movement tendency in the Milky Way galaxy show several spiral nebula bands toward the galactic center. These systems with different scales of space and time have their inherent inertial motion of matter are a consequence of that collision.

In the case of the solar system (or the Earth system), the inertial motion of matter and the potential movement tendency formed by that collision are regular towards the Sun's center (or the Earth's center). The Sun and Earth are the central bodies of their respective systems and have large masses, while the objects moving around them have very small masses. Newton's law of gravity is a good example of a statistical equation describing the inertial motion of a substance (particle) relative to the central body such as the Sun (or the Earth). Newton's gravitational equation has a statistical constant G, which differs from a system to other systems. Newton's gravitational equation simply describes a two-body cosmic system. Einstein's general relativity extended Newton's two-body universe to a complex multi-body cosmic system composed of a central body and many small objects. He replaced Newton's two-body statistical relationship as a complex multi-body system described by the geometric form (geometric relationship) associating with the spatial distribution of matter and energy. In general relativity, the mass and energy of a system, including the evolution and rotation of each member, can be described in its geometric tensor. So, the equations of general relativity describe a complex nonlinear mathematical system, although there are also statistical constants.

Two important transitions from Newton's theory to general relativity are the transition from a simple two-body world to a complex multi-body world, and from a single factor (or two parameters) to multiple factors in a dynamical system. We propose here a fundamental shift in the worldview that is from a passive gravitational action to an active convergence process. The passive gravitational action is caused by the central body of a system to its members. The active convergence process shows that all members tend to move toward the central body under the inertial motion of matter. General relativity can describe the law of Mercury's perihelion precession, but it does not know why the planetary precession law arises. Similarly, neither Newton's law of gravitation nor Einstein's general theory of relativity can account for the different rotation directions between neighboring planets in the solar system [20]. To answer the attribution problem of Mercury's perihelion precession, we need to know what causes the inertial motion of matter (particles) in the solar system.

3. New States of Matter under Orthogonal Collisions

Modern astronomical observations and the rules of planetary motion are traces of a previous cosmic event. The event was a collision between matter and matter in the universe. If there is a convergence interaction between different substances (particles) in a system now, the result of the convergence collision will produce a new state of matter for the future. The new state of matter in the future produced by the collision is different from the current state of matter, and it is also different from the state of matter before the last collision. The state of matter before and after each collision is different, and the information connected between the two states before and after the collision cannot be found. Like collisions between nuclear reaction particles, the mass-energy transition occurs, leaving behind an event trace, the inertial motion of matter.

We consider the collision between two objects or particles in the universe. The two particles have a change in mass and velocity. Mass is a scalar, while velocity is a vector with changes in magnitude and direction. The particle velocity and direction can be expressed by the centripetal force and the inertial force of the particle motion in classical mechanics, respectively,

$$\boldsymbol{F}_A = \frac{m_A}{r_A} v_A^2 \boldsymbol{n}_A + m_A a_A \boldsymbol{k}_A \tag{1}$$

and

$$\boldsymbol{F}_B = \frac{m_B}{r_B} v_B^2 \boldsymbol{n}_B + m_B a_B \boldsymbol{k}_B . \tag{2}$$

where the term $\frac{m}{r} v^2 \boldsymbol{n}$ is a mass centripetal force with mass m and velocity v at the $\boldsymbol{n}$ direction and the term $ma\boldsymbol{k}$ is a force of mass acceleration ma at the $\boldsymbol{k}$ direction. Two terms ($\frac{m}{r} v^2 \boldsymbol{n}$ and $ma\boldsymbol{k}$) are two components of the force $\boldsymbol{F}$. The letter r is a motion radium of an object or particle relative to his central body. In addition to having mass, all objects (particles) have motion and physical characteristics relative to energy, including charges (electric charge and color charge) and spin or momentum. All objects (satellites and planets) and particles have their rotations and orbits, so that every particle in the universe has an orbit relative to its moving center.

We consider a collision between two particles. As a result of the collision [20],

$$\boldsymbol{\tau}_X^{+i,-j} = \left(q_A^+ \frac{m_A}{r_A} v_A^2 \boldsymbol{n}_A + q_A^+ m_A a_A \boldsymbol{k}_A \right) \times \left(q_B^- \frac{m_B}{r_B} v_B^2 \boldsymbol{n}_B + q_B^- m_B a_B \boldsymbol{k}_B \right). \tag{3}$$

where the shear stress $\boldsymbol{\tau}_X^{+i,-j}$ is a result of two external forces acting, the letter X represents types of result or product, the letters i and j denote different kinds of object (particle), and the signs + and − indicate different charges of object (particle) in different macroscopic (or microscopic) worlds.

This shear stress in Equation (3) describes the evolutional tendency of object

(particle) motions with space and time because the term $ma\boldsymbol{k} = m\frac{\mathrm{d}v_k}{\mathrm{d}t}\boldsymbol{k}$ spatially shows the expanding outward and contracting inward of objects (particles) with time. It can express as four terms in more detail,

$$\begin{aligned}\boldsymbol{\tau}_X^{+i,-j} = &\left(q_A^+\frac{m_A}{r_A}v_A^2\right)\cdot\left(q_B^-\frac{m_B}{r_B}v_B^2\right)\cdot\left(\boldsymbol{n}_A\times\boldsymbol{n}_B\right) && (a)\\ &+\left(q_A^+\frac{m_A}{r_A}v_A^2\right)\cdot\left(q_B^-m_Ba_B\right)\cdot\left(\boldsymbol{n}_A\times\boldsymbol{k}_B\right) && (b)\\ &+\left(q_B^-\frac{m_B}{r_B}v_B^2\right)\cdot\left(q_A^+m_Aa_A\right)\cdot\left(\boldsymbol{n}_B\times\boldsymbol{k}_A\right) && (c)\\ &+\left(q_A^+m_Aa_A\right)\cdot\left(q_B^-m_Ba_B\right)\cdot\left(\boldsymbol{k}_A\times\boldsymbol{k}_B\right) && (d)\end{aligned} \tag{4}$$

Among the four terms (*a*, *b*, *c*, and *d*), the last three terms contain the acceleration $\boldsymbol{a}$. Thus, the role of the terms $\left(q_A^+m_Aa_A\right)\boldsymbol{k}_A$ and $\left(q_B^-m_Ba_B\right)\boldsymbol{k}_B$ is to make the universe expanding or contracting at an accelerating rate.

Newton's gravitational equation and Einstein's general relativity, which describe the motion of the universe, contain the statistical constant *G*. Equation (3) describes the evolution of the entire universe without considering any statistical constants. In this equation, in addition to charge, only two factors are mass and velocity and their variation. The absence of any constants in Equation (3) or in Equation (4) is a distinguishing feature from Newton's equation of universal gravitation and Einstein's equations of general relativity.

4. Attribution of Mercury's Precession

We start with a diagram of the orbits of Newton and Einstein's planets. In general relativity, apsides of any orbit will process. The orbit is not a closed ellipse, but akin to an ellipse that rotates on its focus, resulting in a rose curve-like shape. For example, in Figure 1, the perihelion of a planet drifts in a counterclockwise direction relative to the focus on the Sun. At the same time, the direction of

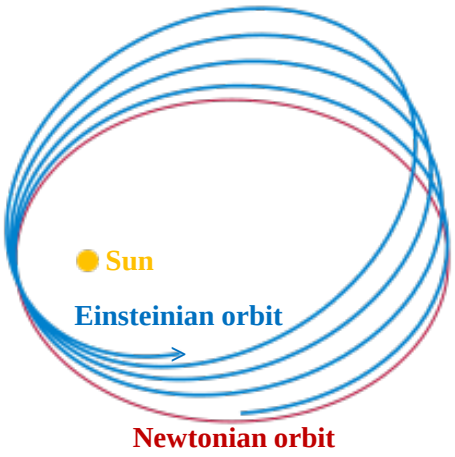

Figure 1. Newtonian orbit (red curve) and Einsteinian orbit (blue curve) of a lone planet such as the Mercury orbiting the Sun.

the long axis of isolated planet orbits also slowing changes. By using an approximate metric to express the Newtonian limit and treating the orbit of the planet as a test particle, Einstein derived the precession trajectory of the blue line in Figure 1. His theory directly explains the anomalous perihelion shift discovered by U. Le Verrier in 1859. It means that if the effect of space-time curvature is considered, general relativity can easily explain the precession difference. Averaging multiple successive ellipses of Einsteinian orbits yield a Newtonian elliptical trajectory of planetary motion (red line ellipse in Figure 1). The general relativity equations correctly describe the motion of planets when noted the fact that relative to Newton's elliptic trajectory is important evidence. Both Newton's gravitational theory and Einstein's general relativity can give a description of Mercury's orbit, but no one has yet given a physical reason for the difference in trajectory between them.

Einstein's equations do a good job of describing Mercury's orbit relative to the Sun over time, but its attribution is unclear. As with Newtonian mechanics, we only consider the universe where two bodies collide. The influence of other planets is ignored. The expansion and contraction that occur are not considered in the results of this cosmic collision. In Equation (3), only two objects (particles) with their centripetal forces collide each other. The shear stress caused by the collision is,

$$\boldsymbol{\tau}^{A,B} = \left(\frac{m_A}{r_A} v_A^2\right) \cdot \left(\frac{m_B}{r_B} v_B^2\right) \cdot \left(\boldsymbol{n}_A \times \boldsymbol{n}_B\right). \tag{5}$$

where r_A and r_B are the moving radius of two objects (particles), the direction of shear stress $\boldsymbol{\tau}^{A,B}$ is perpendicular to the plane formed by two unit vectors $\boldsymbol{n}_A \times \boldsymbol{n}_B$. After a collision, the shear stress modulus is,

$$\tau = \left(m_A v_A^2\right) \cdot \left(m_B v_B^2\right) \sin\theta / r^2 . \tag{6}$$

where θ is the angle between two directions $\boldsymbol{n}_A$ and $\boldsymbol{n}_B$. The shear stress modulus can be seen as the density of mass-energy product (or mass-energy density for simply) formed by the collision of two objects (particles), which is distributed in a new area r^2. We study a new cosmic system left behind by the collision consisting only of the Sun and Mercury. The state of matter of the old universe before the formation of this new universe was not known. During this extreme collision, previous information was lost. The shear stress modulus or the new mass-energy density τ formed by this system is determined. The term, $m_A v_A^2$, is the mass-energy of the Sun in the new state of matter. The Sun is constantly undergoing nuclear reactions and consuming mass. The Sun also has a speed v_A in the sky. It orbits around the center of the Milky Way galaxy and fluctuates on the spiral arm on which it sits and rotates. The mass-energy of the Sun varies over time.

From Equation (6), we have only considered the orthogonal (angle 90 degrees) collisions, *i.e.*, to see how the mass-energy density is when $\sin\theta = \sin\left(\frac{\pi}{2}\right) = 1$.

Then, we move the Sun's mass-energy expression to the left-hand side,

$$\tau/\left(m_A v_A^2\right)=\left(m_B v_B^2\right)/r^2 . \tag{7}$$

We take the ratio of the shear stress modulus (or the total mass-energy density) of the system to the mass-energy of the Sun as $K=\tau/\left(m_A v_A^2\right)$. We can consider that this ratio does not change with time, or changes over time. Thus, we have,

$$Kr^2=mv^2 . \tag{8}$$

where, r is the distance of Mercury relative to the Sun, m and v are the mass and velocity of Mercury, respectively. Considering that the mass of Mercury does not change, in the above formula, K and r and v are change over time. To find the derivative of time, it has,

$$r^2\frac{\mathrm{d}K}{\mathrm{d}t}+2Kr\frac{\mathrm{d}r}{\mathrm{d}t}=2mv\frac{\mathrm{d}v}{\mathrm{d}t} . \tag{9}$$

If the ratio K does not change with time ($\frac{\mathrm{d}K}{\mathrm{d}t}=0$), then the above equation is,

$$Kr\frac{\mathrm{d}r}{\mathrm{d}t}=mv\frac{\mathrm{d}v}{\mathrm{d}t} . \tag{10}$$

The trajectory formed by the change of two variables v and r with time t is an ellipse. Equation (10) shows that Mercury has the shortest elliptic radius and the slowest velocity when it is at perihelion. When Mercury is at aphelion, it has the longest ellipse radius and the fastest velocity. When Mercury is at perihelion and aphelion, changes in radius length and velocity with time are 0, so that perihelion and aphelion are two special locations on the ellipse. As Mercury moves from perihelion to aphelion, the radius r increases with time t, namely $\mathrm{d}r/\mathrm{d}t>0$. The closer to the aphelion, the larger $r\mathrm{d}r/\mathrm{d}t$ and the faster speed v and the larger $v\mathrm{d}v/\mathrm{d}t$ are. Mercury returns from aphelion to perihelion in the opposite tendency. Mercury's path is an elliptical orbit under Newtonian gravity. Under this limit, Mercury orbits to meet the Kepler's second law, sweeping out the equal area within the ellipse in the equal time interval.

If the radius of Mercury's orbit around the Sun is constant, namely $\frac{\mathrm{d}r}{\mathrm{d}t}=0$, we have $\frac{\mathrm{d}v}{\mathrm{d}t}=0$, Mercury travels in an exact circle. If the ratio K changes over time but is a constant, namely $\mathrm{d}K/\mathrm{d}t=C$, then,

$$K\frac{\mathrm{d}r^2}{\mathrm{d}t}-m\frac{\mathrm{d}v^2}{\mathrm{d}t}=-r^2C . \tag{11}$$

This constant C at the right-hand side of Equation (11) acts with Mercury's distance r squared relative to the Sun, which causes the position of the ellipse at the left-hand terms to drift over time. Therefore, $-r^2C$ is a core term for the drift of Mercury's perihelion. Obviously, when this core term is 0, Mercury's perihelion does not drift. The path of Mercury is an elliptical orbit which can be derived from Newton's gravity. The statistical equation of Newton's theory of gravity does not consider the change in the mass-energy of this entire system

relative to the Sun over time, only the mass and distance factors. If considering the fine changes in the mass and momentum (energy) of the Sun-Mercury system in Einstein's general theory of relativity, one can accurately get the change in the precession of Mercury over time. This comprehensive mass-energy change is missing from Newton's statistical equations of gravity. Therefore, Equation (11) can explain the reason of discrepancy between Newton's gravity's calculation and observation for the precession of Mercury. It also showed why the Einstein's theory can correctly predict the advance of the perihelion of Mercury.

The previous formula shows that the precession of a planet is relative to the change in the mass and energy of the Sun, to the change in the mass and energy of the entire system, and to the change in the mass and energy of the planet, as well as the distance between the planet and the Sun. Therefore, planets with different masses, momentums (obit and rotation), and distances from the Sun have different precessions. If other factors are not changed with time, the perihelion precession of planets per orbit is proportional to his distance relative to the Sun. Mercury is the inner most one of the four terrestrial planets in the solar system so that it should have the smallest precession theoretically. But the precession frequency of Mercury is the highest due to the shortest distance relative to the Sun. The above result showed that Newton's theory of gravity is a simplification of Einstein's general theory of relativity, while the latter is a simplification of the inertial theory of matter motion.

5. Conclusions

The inertial motion of matter in the universe has multiple levels of space and time. Through this attribution study of Mercury's precession, we can trace that the current distribution of matter and energy in the solar system is the product of a matter collision (local cosmic explosion) and the traces left by the collision. The Sun is the center of the solar system in this remnant. That collision determined not only the orbit and rotation of moons around its planet, the orbit and rotation of planets around the Sun, but also the orbit and rotation of the Sun around the center of the Milky Way galaxy. Multi-level systems at different times and at different spaces have been nested and formed. What describes the relationship between these systems is their mass and momentum (energy).

The inertial theory of matter motion in the universe is a new worldview. The collision (or explosion) formed the inertial motion of each object, which can also be collectively referred to as the mass-energy inertia of object motion. The rules of motion among all members within each system follow mass-energy inertia. Mass-energy inertia shows the tendency of matter motion and is a product of collision. The matter in each system tends to move the center of the system. This inertial tendency of matter motion gives the impression that all matters are attracted by the central body in the system or seduced at a distance. We need to convert the passive seduction of members in a system by the centrosome into the active convergence of members to the centrosome under inertial motion. This change in thinking about the relationship between things is a change in position

or a change in world view.

Newtonian gravity and Einstein's theory of relativity are two types of description for the real world. Newton described the inertial tendency of matter motion produced by this collision as gravity, which is a seduction at a distance. Therefore, Newton's law of universal gravitation is to describe the visual motion relationship between objects as a perceptual and statistical law. In daily life, the causal relationship between many things is not clear, but statistical laws between them are still useful. That is why the statistical relations of Newtonian mechanics do not account for the physical nature of gravity. Einstein's general theory of relativity, a rational geometric description of visual motion between objects, avoids this "seduction" at a distance. General relativity includes not only the mass of a moving object, but also the distribution of all the momentum (energy) of the object's motion in space-time, thus approaching the real world.

Planetary precession is the space-time distribution of mass and energy at the beginning of the formation of the solar system. During the orthogonal collision of the formation of the solar system, we hypothesized that a two-body cosmic system of the Sun and Mercury was formed. In this cosmic system, we get that the reason for Mercury's perihelion precession comes from the ratio of the system's shear stress modulus to the Sun's mass-energy and its change over time. Their modulus and mass-energy include multiple factors such as the mass, rotation, and revolution of the Sun and Mercury. It is further derived that the precession of planets is proportional to the distance from the Sun if without considering other factors. Therefore, considering only the distance factor, the smallest and fastest precession occurs for the orbit of Mercury in the four terrestrial planets theoretically. This theory not only explains why general relativity can more accurately calculate Mercury's precession, but also shows that Newton's gravity describes the elliptical path of planetary motion as the statistical average of the former.

The inertial theory of matter motion can play as a third estimation for the Mercury's precession. There are many ways to estimate the perihelion precession of Mercury. Different methods are based on different factors of action. Newton's gravity describes the orbit of Mercury as just one factor that considers the masses between the Mercury and the Sun. Einstein's general theory of relativity considers the space-time distribution of mass-energy in the system, so it correctly calculates the precession of Mercury. The theory in this paper is a good illustration of many influencing factors that should be present in a system to produce planetary precession. Many other predictions of Mercury's precession are based on individual guesses on the impact factor. Therefore, this theory can provide more effective factor considerations for describing various astronomical events and relationships between the movements of celestial bodies using general relativity equations.

6. Discussion

The collision of accelerated particles can lead unimaginable extreme events. In

this paper, only the collision result of two-particle centripetal forces is theoretically given in Equation (5). In Equation (4), the collision results between the centripetal force and the mass inertial force, as well as between the two mass inertial forces have not yet been analyzed. Their collision will form different states of matter and inertial motion directions of new matter, and there will be a spatial expansion of new cosmic matter. These terms describe accelerated collisions between particles that can form unimaginable extreme events (or new things, new states of matter). The planetary precession is simply a consequence of the centripetal force interaction of two particles.

The shear stress vector determines the direction of the planet's rotation. In Equation (5), we only consider the application of the shear stress modulus in describing the precession of Mercury, but do not analyze the direction of the shear stress. The shear stress has two opposite directions relative to the collision point. When a planet forms, the total shear stress formed by the collision of all nebular materials is perpendicular to the planet's rotation equatorial plane. So, these two directions determine the axis of the planet's rotation. Every planet and every moon in the solar system should have a different axis of rotation.

Einstein was not able to move away from his concerns. He once struggled with the general relativity tensor equation about whether it could describe the expansion and contraction of the universe. In a new edition of his popular book on relativity published in 1931, he added in appendix explaining why the term (the cosmological constant) he had pasted into his field equations was, thankfully, no longer necessary [21]. He remarked that the introduction of the cosmological term was the biggest blunder he ever made in his life. This story implies that general relativity is a geometric speculation about the real world. Equation (3) does not contain any constant terms. In the vector decomposition of Equation (4), the last three terms describe the expansion and contraction of the universe. Equation (5) describes the interaction formed by the curvilinear motion of objects in the universe. Among them, orthogonal collisions between objects are the best way to form the maximum shear stress modulus or excite the maximum mass-energy density. Many new physical states and new things in nature are the product of orthogonal collisions.

The Mercury precession is an inertial motion of the planet. Mercury's elliptical orbit around the Sun moves in variable velocity like a roller coaster. Mercury has the greatest potential energy and the least velocity at perihelion, and the least potential energy and maximum velocity at aphelion. The orbital motion of a planet belongs to its mass-energy inertial motion. Like a pendulum, the formation of initial relative potential energy requires an external force. The pendulum then undergoes a continuous transition between potential energy and kinetic energy over time. Meanwhile, as the Foucault pendulum in 1851, it was the first demonstration of the Earth's rotation and illustrated the precession. This is an experiment in the observation of the inertial motion for the Earth's precession. The first driving force of planetary motion is the orthogonal collision when the solar system formed. The precession of each planet's orbital motion with respect

to the Sun also comes from an initial inertial motion.

There are no gravitational perturbations between neighboring planets. A planet should also be able to form on the asteroid belt. But the inertial motion of these asteroids lacks a convergence component. As we know that the orbital speed of the planets of the solar system decreases from Mercury outward. If these planets in the solar system are shattered into like what they are now in the asteroid belt, or even smaller nebulae, then the speed of these asteroids and nebulae orbiting the Sun is also decreasing. Fluctuations occur in the decreasing velocity of this diffuse matter. From a peak to an adjacent valley and then to a next peak, opposite nebular vorticities form on two adjacent nebulae wave belts, which are planetary embryos rotating in opposite directions. This could explain the fact that the almost opposite rotation directions exist between adjacent Mercury and Venus and Earth [20]. Earth and Moon, as well as Mars and its two moons, form in the same wave belt of planetary embryos, so that they have the same direction of rotation. The formation of the inclination of each planet's rotation axis is related to the overall convergence tendency (inertial motion) of all the embryos that make up the planet. The rotation and revolution of planets are the result of the convergence of inertial material motion so that they have nothing to do with the gravitational pull between planets.

The attribution of planetary precession is not the Newton's theory of gravity. In the case of the formation of the Earth, its precession has two inertial components associated with its rotation and revolution. There is now an asteroid belt between Mars and Jupiter in the solar system. Each asteroid is orbiting the Sun and rotates, which are traces left at the beginning of the formation of the solar system. Originally, the Earth embryo was located on a nebula shear belt. The formation of the Earth is brought together by the inertial motion of many small embryos. So, the rotation and revolution of the Earth gather the angular momentum of all those embryonies. The number and mass of small embryos converging on either side of the Earth's embryonic equator are not uniform, and the orbits of all small embryos relative to the Sun are not symmetrical and uniform. The two types of the unevenness of inertial material motions are responsible for the formation of two components in the planetary precession. The convergence of all asteroid's inertial material motions forms the Earth's precession. The formation of other planetary precessions is similar.

There is no gravitational relationship between planets and moons. According to the collision theory of inertial material motion, the information before the formation of the solar system is gone. The relationship between the motion of the Earth and the Moon in the Earth system, the motion relationship between Mars and its two moons in the Mars system, the relationship between the movement of all matter on the asteroid belt, the relationship between Saturn and its moons and light rings in the Saturn system, and the relationship between Jupiter and its moons and light rings in the Jupiter system, they still follow the inertial motion of matter left behind. Each system has its own center of inertial material motion. Therefore, the relationship connected between a planet and its

moons is not gravity, but their respective inertial motions of matter.

Solar storms are high-speed inertial motion of particles excited by nuclear reactions on the Sun. During the solar system formation, the convergence and collision of the inertial motion of substances form the high-speed rotation of the Sun. At the same time, matter colliding on the Sun at different latitude and longitude positions has different velocities. They cause unequal velocities in different spheres and at different latitude and longitude points in the Sun's interior. Still to now, the relative motion and collision of matter at different scales on the Sun through nuclear reaction excite lot of particles of small mass. These particles can exceed their escape speed and become particles (including photons) fleeing the Sun. When lots of particles on the surface of the Sun converge at a local position through orthogonal collision, the so-called sunspot phenomenon occurs. Sunspots can trigger solar storms. High-energy particles coming from a solar storm can exceed the normal speed of sunlight. These energetic particles from the Sun and magnetospheric particles from the Earth tend to collide orthogonally over the Earth's poles, forming the so-called aurora phenomenon [22].

Three theories for the universe form in three eras. The formation of three theories, from the Newton's theory of gravity to the Einstein's general theory of relativity and the theory of inertial matter motion, is a process by which people gradually understand the universe. The Newton's gravity is an extremely intuitive statistical theory. The proposal of gravity has made a great contribution to people's use of the laws in practice. But the question on the nature of gravity was not answered for his lifelong regret. Einstein's thoughts and life were extremely active and complex [21]. He described the two-body statistical relationship of Newton as the space-time curvature associated with mass-energy distribution using complex geometric mathematics, forming a set of unique general relativity equation. However, general relativity still does not answer the question of the nature of gravity. Therefore, his later goal was to unify field theory, hoping to answer this question. The inertial theory suggests that people can change the worldview of Newton and Einstein. One should believe that the orthogonal collision can create a new physical state. The changes in the old and new worlds are attributed to orthogonal collisions between matters. It can be expected that the inertial theory of matter motion and the principle of orthogonal collision can play a benefit role in people's daily life. People can flexibly use these three theories on different occasions to solve different problems.

There is a gradual process of Mercury precession interpretation and estimation. As an astronomical fact, the traditional explanation for Mercury precession is gravity. However, there is a discrepancy between gravity's calculation and observation for the precession of Mercury. In the middle 19th century, people attributed this discrepancy as the gravitational perturbation of another planet that might be near Mercury. When the expectation of a new planet was disappointed, other theories of Mercury's precession were proposed, but they were still related to gravity. In the late 19th century, Gerber explained the anomalous precession of Mercury's perihelion in terms of a velocity-dependent potential [23]. He be-

lieved that gravity propagates with space and time. At the beginning of the 20th century, Einstein proposed the theory of relativity, which was more accurate than Newton's gravity. Although various algorithms for Mercury's precession were proposed [2], but they are still not free from the ideological shackles of gravity.

The proposal of three Mercury's precession theories is based on two different worldviews. Physically, Newtonian gravity only considers the orbit of a planet relative to the Sun, while general relativity considers both the orbit and rotation of a planet. Mathematically, Newtonian gravity gives the statistical relationship between two objects, while general relativity gives the space-time mass-energy geometry of the relationship between objects. There is no essential difference between Newtonian gravity and general relativity so that they belong to the same gravitational worldview, but different methodologies. Other works are also based on different approaches in calculation under the same worldview [7]-[16]. This paper proposes an inertial worldview. Physically, the inertial worldview considers the inertial motion of matter to be a legacy of multi-level space-time changes. Mathematically, the inertial worldview describes a sudden change in collision between old and new material masses. Philosophically, the inertial worldview asserts that information between the old and new worlds is disconnected.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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