On the Nature of Gravitation

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Abstract

Based on Einstein's equivalence principle (EEP), a method of describing the gravitational field by the special relativity formula is proposed. The equation for the transformation of the coordinates between the spacetime point of the gravitational field and the inertial reference system is derived. The conclusion that the mass of an object in a gravitational field follows the strength of the gravitational force is obtained. The gravitational drive (curvature drive) effect is briefly described, and it is pointed out that the gravitational drive effect is the source of the dark energy of the Universe. The gravitational drive effect is calculated to produce a negative pressure of matter on the cosmic scale, with a ratio of pressure to energy density of -2/3. It is also calculated that the rotation of the Earth is faster at aphelion than at perihelion under the gravitational drive effect, and that the length-of-the-day (LOD) is reduced by 0.02851 milliseconds. It is analysed that as the solar system orbits the Milky Way, the Galactic plane, the Galactic centre and the Great Attractor all have an effect on the Earth's mass variation, causing a periodic change in the Earth's

mass, which we call a tidal wave of mass. Thus, a galactic year can be divided into four seasons, spring, summer, autumn and winter, according to the influence of the galactic gravitational field environment on the Earth. The Earth is currently in the autumn of the galactic year and is losing mass under the influence of tidal waves of mass caused by gravitational changes in the galactic plane and the galactic centre, which is making the Earth's climate hot and arid. In the future, when the Earth's mass stops decreasing, it will rapidly increase under the influence of tidal waves of mass caused by Great Attractor, and the survival of humanity will be severely tested. We therefore need to establish a broad international cooperation to unite humanity to face the challenges posed by the coming universe.

Keywords:Einstein's Equivalence Principle（EEP), Local inertial system, Lorentz transformation, change of mass of an object in a gravitational field field.

1 Introduction

What is the nature of gravity, this is a problem that mankind has been seeking to solve. Suppose there is an ideal elevator experiment as shown in Figure 1.

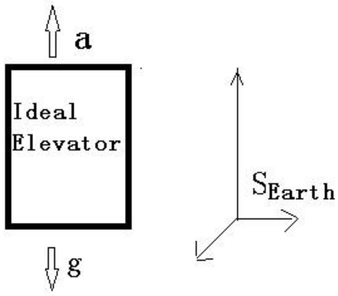

Fig. 1.

When the size of the ideal elevator is small enough, we can assume that (A) If the ideal elevator is allowed to accelerate relative to the inertial system in a distant free universe space, the experimental physicist in the ideal elevator cannot distinguish by any mechanical experiment whether the ideal elevator is subject to gravitational or inertial forces. (B) When the ideal elevator itself is allowed to do free-falling motion on the earth, the experimental physicist in the ideal elevator cannot get an indication of the existence of gravitational force by any mechanical experiment. That is, in this reference system of the ideal elevator, the gravitational force is cancelled out by the inertial force.

Thus we get the equivalence principle: the kinetic effects of the inertial and gravitational force fields are locally indistinguishable [1][2]. In the process of conceiving the general theory of relativity, Einstein extended this principle from mechanical experiments to all physical experiments. That is, any physical effect of inertial force and gravitational force is equivalent in the local area [3][4]. Later people called Einstein's extended principle as Einstein's Equivalence Principle (EEP) [5].

S.Weinberg (USA) formulated the equivalence principle in his "GRAVITATION AND COSMOLOGY" as follows: at each point in space-time in an arbitrary gravitational field, it is possible to choose a "local inertial system" such that in a sufficiently small neighborhood near the point under discussion, the special relativity formulation takes the same form as in an unaccelerated Cartesian coordinate system in the absence of a gravitational field [6].

Einstein established the general theory of relativity by adding the general co-variance principle to the equivalence principle. However, in general relativity, gravity is described in a geometric mathematical way [3], considering gravity as a geometric effect of spacetime bending [5]. General relativity does not provide a more in-depth discussion of why mass can cause spacetime bending.

We have been working on a new way to describe the gravitational field, constructing a new theory to describe the gravitational field based on the Einstein Equivalence Principle (EEP), which derives the equation of the coordinate transformation relation between the spacetime point of the gravitational field and the inertial reference system. The new theory provides a way to describe the gravitational field in terms of the special relativity formulation, attributing the mutual attraction between matter to the action of the gravitational field, making gravity quantifiable and providing the basis for a new quantum theory of gravity. Many new physical concepts are introduced in this paper, so the paper tries to use simple mathematics to describe these new physical concepts in order to avoid mathematical arguments.

2 Derivation of the relational equation for the coordinate transformation of the spacetime point of the gravitational field and the inertial system

2.1 Thought experiment - free fall motion

As shown in Fig.2, suppose: There is a sufficiently small ideal elevator with mass m_0 and no rotation falling freely toward the Earth from infinity. Let there be an inertial reference system $S_{Inertia}(x,y,z,t)$ in the place where there is no influence of the Earth's gravity and a stationary observer B in the inertial system. The coordinate origin of the earth reference system $S_{Earth}(x'',y'',z'',t'')$ is at the center of the earth. Assume a special case where the Earth is not moving so the inertial reference system is stationary with respect to the earth reference system. A reference system is established in the internal space of the ideal elevator, called the local reference system $A_{Elevator}(x',y',z',t')$. The X, Y and Z axes of these three reference systems are parallel to each other. The gravitational constant is G, the mass of the earth is M, the distance between point R in the earth's gravitational field and the center of the earth is r, The coordinates of point R in the inertial reference system $S_{Inertia}$ are $S_{Inertia}(x_R,y_R,z_R)$. The ideal elevator falls freely to the point R in the earth's gravitational field (The point R and the origin of the local reference system $A_{Elevator}(x',y',z',t')$ coincide), and the speed of the ideal elevator is

v at this time. At the point R, since the ideal elevator does free fall motion and the size of the ideal elevator is small enough, it can be considered that the earth's gravitational force is completely canceled by the inertial force inside the ideal elevator. The internal reference system of the ideal elevator can be equated to the inertial system, in which all the physical laws established by special relativity are valid.

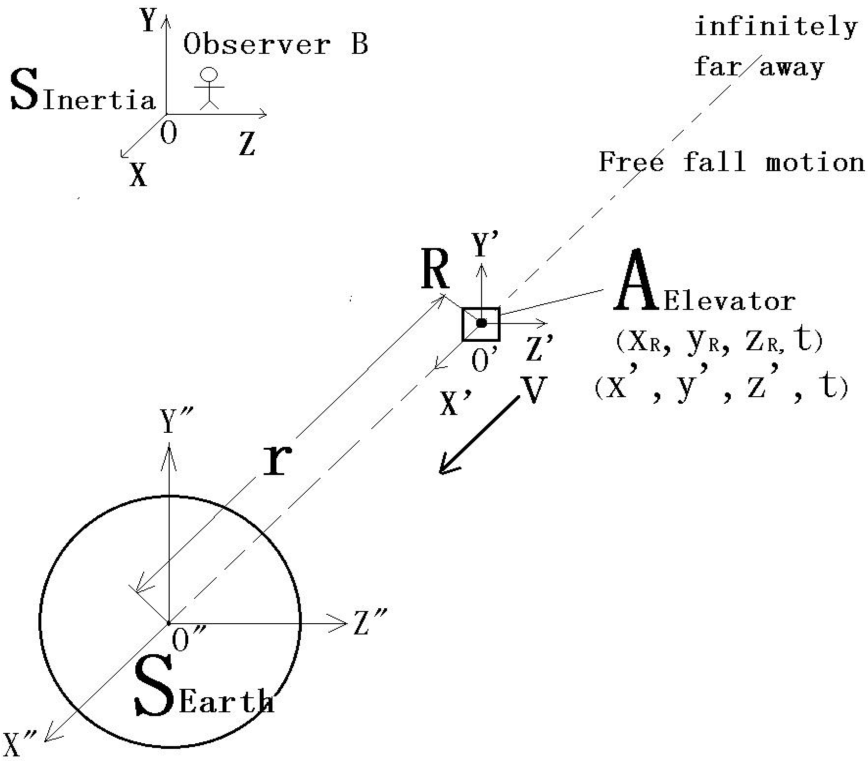

Fig. 2. Free fall thought experiment

2.2 Calculation of physical quantities of the ideal elevator

In the Earth's gravitational field Newton's law holds, so according to the conservation of energy, the kinetic energy E_k and gravitational potential energy E_g of an ideal elevator have the following relationship:

$$-E_g = E_k = \frac{GMm_0}{r} = \frac{1}{2}m_0 v^2 \quad (1)$$

$$v = \sqrt{\frac{2GM}{r}} \quad (2)$$

Equation (2.2-2) shows that the speed of motion of a free falling body is independent of the mass of the falling body. It also shows that at the point R in the gravitational field, the local inertial system $A_{Elevator}(x',y',z',t')$ makes a uniform linear motion with velocity $v = \sqrt{\frac{2GM}{r}}$ with respect to the inertial system $S_{Inertia}(x,y,z,t)$ where the observer B is located.

2.3 Coordinate transformation relations between the spacetime points of the gravitational field and the inertial system

As shown in Figure 2, an object is free falling from infinity to a point R in the Earth's gravitational field. When the size of the object is small enough, according to the equivalence principle, we cannot distinguish whether the object is subject to gravitational or inertial forces throughout its fall when we follow it in free fall. So we can consider that the whole motion of the object is not in free fall in the gravitational field, but in accelerated motion relative to the inertial system in free cosmic space. The velocity of the object is $v = \sqrt{\frac{2GM}{r}}$ when it moves to the point R. Therefore, at the point R, the local inertial system $A_{Elevator}(x',y',z',t')$, makes a uniform linear motion with velocity $v = \sqrt{\frac{2GM}{r}}$ with respect to the inertial system $S_{Inertia}(x,y,z,t)$ where the observer B is located.

According to Einstein's hypothesis: the length of the measuring rod and the operation of the clock are not affected by the acceleration, but are only related to the velocity [7]; also according to special relativity and Lorentz transformation [8][9]. Assuming that the coordinate origin of the local inertial system $A_{Elevator}(x',y',z',t')$ is located at the point R when $t'=t=0$, then at the point R, the local inertial system $A_{Elevator}(x',y',z',t')$ and the inertial system $S_{Inertia}(x,y,z,t)$ have the following relationship equation:

$$dx'=\frac{(x_R+dx)-vdt}{\sqrt{1-\frac{v^2}{c^2}}} \quad (3)\ ; \quad dy'=y_R+dy \quad (4)\ ; \quad dz'=z_R+dz \quad (5)\ ;$$

$$dt'=\frac{dt-\frac{v(x_R+dx)}{c^2}}{\sqrt{1-\frac{v^2}{c^2}}} \quad (6)\ ; \quad c'=c \quad (7)$$

（c' is the speed of light in the local inertial system, c is the vacuum speed of light, $v=\sqrt{\frac{2GM}{r}}$ ）

Based on the above transformations we can derive the following relationship equation:

$$\Delta t=\frac{\Delta t'}{\sqrt{1-\frac{2GM}{c^2r}}} \quad (8)\ ; \quad l=l'\sqrt{1-\frac{2GM}{c^2r}} \quad (9)\ ; \quad m=\frac{m_0}{\sqrt{1-\frac{2GM}{c^2r}}} \quad (10)$$

$\Delta t'$ is the intrinsic time interval of the local inertial system $A_{Elevator}(x',y',z',t')$, l' and m_0 are the intrinsic length and rest mass of the object in the local inertial system $A_{Elevator}(x',y',z',t')$。

3 Application of the transformation equation between the spacetime point of the gravitational field and the inertial system

From the definition of the equivalence principle, it is clear that the smaller the size of the moving object relative to the volume of the gravitational field of the whole planet, the more the motion law of the object conforms to the equivalence principle. The equation of the coordinate transformation relation between the spacetime point in the gravitational field and the inertial system, which is derived from the equivalence principle, also follows this principle. Therefore, when we apply the transformation equation to calculate practical physical problems, we should note that all our calculations are approximations.

Also note that in the thought experiment in Section 2.1 we assumed that the inertial system $S_{Inertia}(x,y,z,t)$ and the Earth's gravitational reference system $S_{Earth}(x'',y'',z'',t'')$ are relatively stationary to each other, and that the local inertial system $A_{Elevator}(x',y',z',t')$ has no rotation. According to special relativity, when an object in a local inertial system has a rotation, the rotating object will produce a Thomas precession[10].

3.1 Gravitational redshift of optical frequencies

According to equation (10): $m=\dfrac{m_0}{\sqrt{1-\dfrac{2GM}{c^2 r}}}$

It is known that for photons there is the equation: $m=\dfrac{E}{c^2}=\dfrac{hf}{c^2}$ （11）

Thus we obtain the following equation:

$$f=\frac{f_0}{\sqrt{1-\frac{2GM}{c^2r}}}\quad(12)$$

Let the radius of the star be r_A, and the photon emitted from r_A propagates to r_B. According to equation (12), the frequency of the photon at r_A is: $f_A=\frac{f_0}{\sqrt{1-\frac{2GM}{c^2r_A}}}$ (13)

When the photon propagates to r_B the frequency becomes:

$$f_B=\frac{f_0}{\sqrt{1-\frac{2GM}{c^2r_B}}}\quad(14)$$

where: $\frac{f_B}{f_A}=\frac{\sqrt{1-(2GM)/(c^2r_A)}}{\sqrt{1-(2GM)/(c^2r_B)}}$ (15)

In a weak gravitational field with $\frac{2GM}{c^2r}<<1$ the following equation can be obtained:

$$\frac{f_B}{f_A}=\frac{\sqrt{1-(2GM)/(c^2r_A)}}{\sqrt{1-(2GM)/(c^2r_B)}}\approx 1-\frac{GM}{c^2}\left(\frac{1}{r_A}-\frac{1}{r_B}\right)\quad(16)$$

The value of the gravitational red shift of the photon is:

$$Z=\frac{f_B-f_A}{f_A}=\frac{\sqrt{1-(2GM)/(c^2r_A)}}{\sqrt{1-(2GM)/(c^2r_B)}}-1\approx -\frac{GM}{c^2}\left(\frac{1}{r_A}-\frac{1}{r_B}\right)\quad(17)$$

Equations (17) are identical to the calculations of general relativity [11]. And the correctness of equation (17) has been verified by a large number of experiments [12][13].

3.2 Precession of the perihelion of the planet、 radar echo delay, and light deflection in the gravitational field

It is known that in the flat spacetime, the Minkowski spacetime line element can be written in the spherical coordinate system as:

$$ds^2 = -c^2dt^2 + dr^2 + r^2(d\theta^2 + \sin^2\theta d\varphi^2) \quad (18)$$

In the spherical coordinate system, the three line elements along the direction of the base vector are:

$dl(r) = dr$； $dl(\varphi) = r\sin\theta d\varphi$； $dl(\theta) = rd\theta$

Thus equation (3.2-1) can also be written as:

$$ds^2 = -c^2dt^2 + dl^2(r) + dl^2(\varphi) + dl^2(\theta) \quad (19)$$

Suppose a mass point of mass M is placed at the origin of coordinates, then a gravitational field is established in space. The gravitational field sphere coordinate point corresponding to the flat space-time sphere coordinate point $P(r, \theta, \varphi)$ is $P'(r', \theta', \varphi')$.

According to section 2.3, for any point P' in the gravitational field there is the following conclusion: a small object at point P' in the gravitational field is subjected to the gravitational field, which is equivalent to the uniform linear motion of the small object in the free cosmic space with respect to the inertial system. Therefore the line element near the point P' has the same form as the equation (19) and can be written as: $ds'^2 = -c'^2 dt'^2 + dl'^2(r') + dl'^2(\phi') + dl'^2(\theta')$ (20)

After establishing the gravitational field, it is obvious that the gravitational field generated by the mass point M is spherically symmetric and acts only in the diameter direction, in other directions the gravitational field is 0. Therefore, in the three line elements of the spherical coordinate system, only $dl(r)$ changes, the other two line elements remain unchanged: $dl'(\varphi') = dl(\varphi)$ ； $dl'(\theta') = dl(\theta)$

where $ds'^2 = -c'^2 dt'^2 + dl'^2(r') + dl^2(\phi) + dl^2(\theta)$ （21）

$$ds'^2 = -c'^2 dt'^2 + dr'^2 + r^2(d\theta^2 + \sin^2\theta d\varphi^2) \quad (22)$$

Observing the point P' in the gravitational field from the inertial system, according to equations (8) and (9) we have:

$$dt' = dt\sqrt{1-\frac{2GM}{c^2 r}} \quad (23) \qquad dr' = \frac{dr}{\sqrt{1-\frac{2GM}{c^2 r}}} \quad (24)$$

According to equation (7), the speed of light at point P' in the gravitational field is: $c' = c$

Substituting equations (23), (24), and (7) into equation (22) yields the line element of the gravitational field of the spherically symmetric stationary as:

$$ds'^2 = -\left(1-\frac{2GM}{c^2 r}\right)c^2 dt^2 + \frac{dr^2}{1-\frac{2GM}{c^2 r}} + r^2\left(d\theta^2 + \sin^2\theta d\varphi^2\right) \quad (25)$$

In fact, equation (25) is the same as the Schwarzschild metric of Einstein's general relativity. Since the volume of the planets is small enough relative to the entire solar gravitational field, the planets can be treated as mass points and the equivalence principle holds. Therefore, from the equation (25) (which is the Schwarzschild metric), the Precession values of perihelion of planets can be solved, and the delay time of the radar echo delay effect and the deflection angle of the light in the gravitational field can also be calculated. The detailed solution has been discussed in many previous papers [14] and will not be developed in detail here.

If the effects of the charge, magnetic distance, and spin of the planet on time, space, and coordinates are taken into account, as well as the selection of different coordinate systems, various line elements of the local inertial system in the gravitational field under the influence of charge, magnetic distance, and spin can be obtained, which can correspond to various solutions of the general relativistic gravitational field equations. Also the gravitational radiation of the planet can be deduced if the vibration of the planet is taken into account. This is not developed in detail here.

According to Section 2.3, equation (25) can also be written as:

$$ds'^2 = -\left(1-\frac{v^2}{c^2}\right)c^2dt^2 + \frac{dr^2}{1-\frac{v^2}{c^2}} + r^2\left(d\theta^2 + \sin^2\theta d\varphi^2\right) \quad (26)$$

Therefore, the $\frac{2GM}{r}$ term in equation (25) represents the velocity, and $\frac{2GM}{r}$ needs to be taken as a whole to have actual physical meaning. So using any mathematical method to eliminate the singularity of equation (25) at $r=\frac{2GM}{c^2}$ will make equation (25) lose its physical meaning. In addition, $v=c$ when $r=\frac{2GM}{c^2}$, at which point the equivalence principle fails, so equation (25) can only be used to describe the physical world outside the black hole and cannot be used to describe the situation inside the black hole. (The problem of black holes will be discussed in detail in a separate article)

4 Changes in the mass of an object in a gravitational field and the gravitational drive (curvature drive) effect

According to equation (10)： $m=\frac{m_0}{\sqrt{1-\frac{2GM}{c^2r}}}$ The equation shows that the mass of an object in the gravitational field follows the change in r. This equation has been verified in section 3.1 Gravitational redshift of the optical frequency. Since the quarks that make up the proton-neutrons, the total static mass is only about 1% of the proton-neutrons [15], leaving about 99% of the mass in the form of energy. This means that 99% of the mass of the macroscopic object is in the form of energy, and therefore the mass change of the macroscopic object in the gravitational field is also in accordance with equation (10).

Let: In the gravitational field there is a mass of m object Q to speed v_1 movement, at this time the object has kinetic energy for : $E_Q=\frac{1}{2}mv_1^2$. Suppose we can completely remove the gravitational field acting on the object at this time, according to (10) the mass of the object becomes m_0. At this time the speed of motion of the object Q becomes v_2, according to the conservation of energy: $v_2=v_1\sqrt{\frac{m}{m_0}}$ (27)

The velocity of an object's motion increases due to the decrease of the gravitational field, a phenomenon we call the gravitational drive effect. From the perspective of spacetime, this effect is caused by the change in curvature of spacetime, so it can also be called the curvature-driven effect. Under the effect of gravitational drive, matter provides negative pressure on the cosmic macroscopic scale, with the ratio of pressure to energy density being: $w=\frac{p}{\rho}=-\frac{2}{3}$ (28)

According to equation (26), the gravitational driving effect is small in the early and late stages of the expansion of the Universe, and only in the middle stage of the expansion does the gravitational driving effect cause a significant acceleration of the Universe. The magnitude of the gravitational driving effect is proportional to the distribution of matter and energy in the universe. The gravitational driving effect is therefore the source of the dark energy of the Universe.

Based on the actual astronomical data, we can make the following ideal assumptions in order to facilitate theoretical studies:

The distance between location R1 on Earth and the center of the Earth is : $r_1=6371000\mathrm{m}$

The distance between location R2 on Earth and the center of the Earth is: $r_2=6371000+2000=6373000\mathrm{m}$

The Earth orbits the Sun and the distance between the Earth and the Sun at perihelion is : $L_{\text{Perihelion}}=1.471\times10^{11}\mathrm{m}$

At aphelion, the distance between the Earth and the Sun is:

$$L_{\text{Aphelion}}=1.521\times10^{11}\mathrm{m}$$

The nearest distance from location R1 on Earth to the Moon is:

$$L1_{Moon}=384400000\mathrm{m}$$

When the Moon turns behind the Earth, the distance from location R1 on the Earth to the Moon is: $L2_{Moon}=384400000+6371000\times2=397142000\mathrm{m}$

Known: Earth GM[16][17]: $GM_E=398600.4418\times10^9\mathrm{m}^3\cdot\mathrm{s}^2$

Sun GM[18]: $GM_S = 1.327\,124\,420\,99 \times 10^{20}\,\mathrm{m}^3 \cdot \mathrm{s}^{-2}$

Lunar mass[19]: $M_L = 0.0123 M_E$

Universal gravitational constant [20]: $G = 6.67428 \times 10^{-11}\,\mathrm{N} \cdot \mathrm{m}^2 / \mathrm{kg}^2$

Follow equation (10) to calculate the difference in mass of a 1 kg object between two locations on Earth, R1 and R2:

$$\varDelta m_{R1-R2-Earth} \approx 0.218 \times 10^{-12}\,\mathrm{kg}$$

Calculate from equation (10) that when the Moon rotates from its closest distance from point R1 to the back of the Earth at its farthest distance from point R1, the amount of change in mass of a 1kg object at point R1 during this period is:

$$\Delta m_{R1-Moon} \approx 0.455 \times 10^{-14}$$

According to equation (10), at perihelion, when the Sun rotates from its closest distance from location R1 to the back of the Earth at its farthest distance from point R1, the amount of change in mass of a 1 kg object at point R1 during this period is:

$$\Delta m_{R1\text{-}Sun} \approx 0.86945 \times 10^{-12}\,\mathrm{kg}$$

According to equation (10) and the equation for conservation of angular momentum, it can be calculated that the rotation of the Earth at aphelion is faster than at perihelion, and the change in length-of-day (LOD) is:

$$LOD = 86400 \times \left(\frac{M_E - \Delta M_E}{M_E} - 1 \right) \approx -0.00002851\mathrm{S} = -0.02851\mathrm{ms}$$

(ΔM_E is the reduced mass of the Earth at the aphelion)

As the Earth orbits the Sun, the mass of the Earth forms a cycle of change under the influence of the Sun's gravity in what we call a tidal wave of mass due to changes in the Sun's gravity. From the above calculations it can be seen that the effect of the Sun's gravity on the change in Earth's mass is much greater than the effect of the Moon's gravity on the change in Earth's mass.

5 The impact of the Milky Way's gravitational field environment on Earth

Gravitational driving effects can affect not only the rotation of the Earth, but also various aspects of the Earth's plate movements, ocean fluctuations, atmospheric circulation, weather, etc. Using the same method as above, it is possible to calculate the effect of gravitational variations in the Galactic plane and the Galactic centre on the mass of the Earth. The calculations show that the effect of the gravitational pull of the Galactic centre on the Earth's mass follows the Sun's orbit around the Galactic centre, which we call the tidal wave of mass caused by the change in the Galactic centre's gravity. As the Sun periodically crosses the Galactic plane, a tidal wave of mass due to changes in the gravitational pull of the Galactic plane is also formed. It is also important to consider that the Milky Way is falling towards a Great Attractor at 627 ± 22 km/s [21][22], so that the fall velocity of the solar system varies significantly as it orbits the Milky Way for a week. This results in a relatively large periodic variation in the mass of the solar system, which we call a tidal wave of mass caused by the Great Attractor.

The Sun is known to orbit the Milky Way at a speed of about 220 km/s, and it takes about 240 million Earth years for the solar system to orbit the Milky Way. It is expected that the Earth and the solar system together will be accelerated to about 847 ± 22 km/s in about 95 million years, by which time the mass of the Earth will have increased substantially. We divide a galactic year into four seasons, spring, summer, autumn and winter, every 60 million years, according to the effect of the galaxy's gravitational field environment on the Earth. We define the period of time when the Earth's fall velocity relative to the Great Attractor accelerates to its maximum velocity as the winter of the galactic year.Figure 3 shows the position of the Great Attractor relative to the Milky Way and the division of the Milky Way into annual seasons. The positions of the solar system in the Milky Way at the time of the five biological mass extinctions in Earth's history are marked on the diagram.

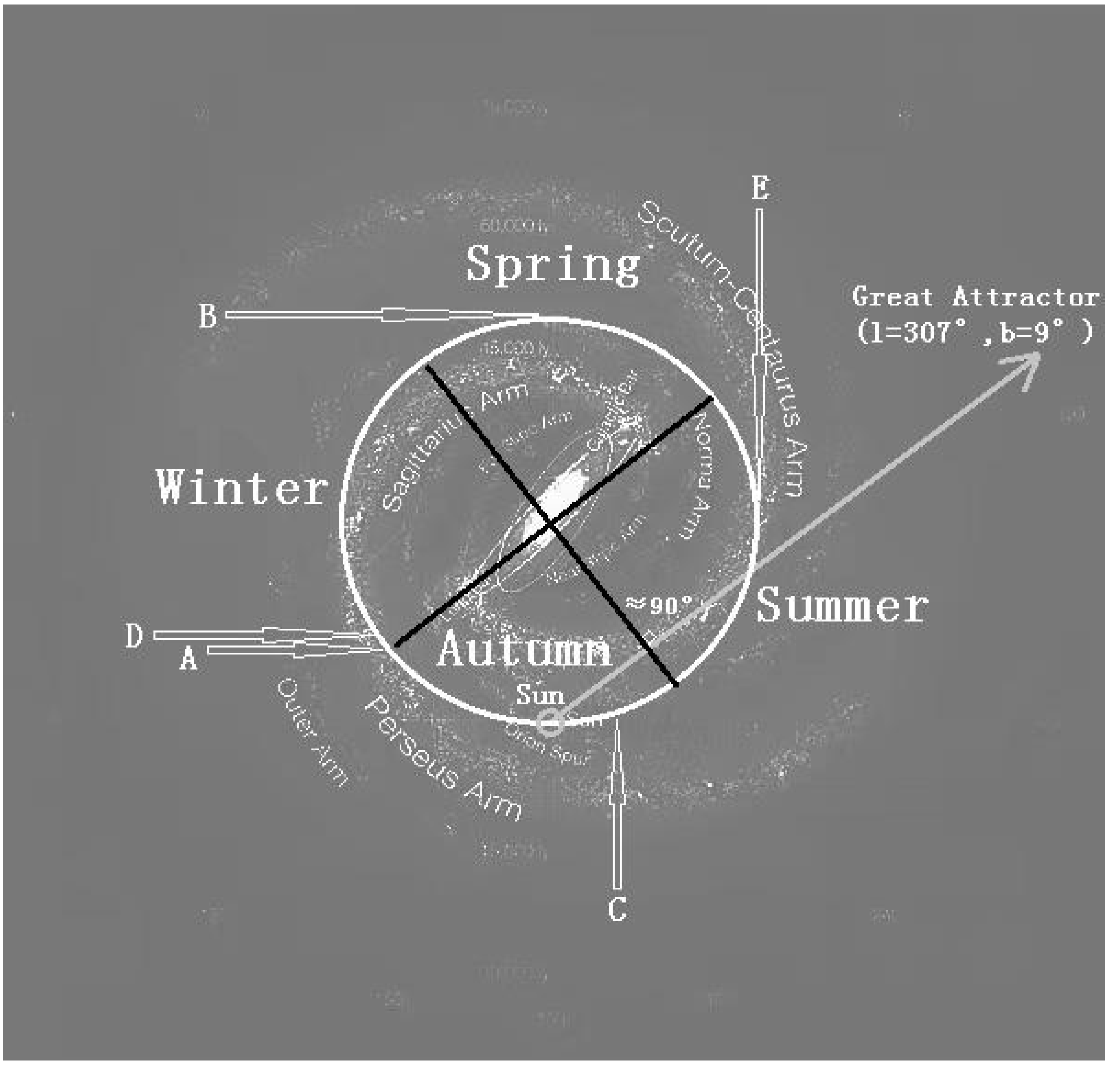

Fig. 3. The division of the galactic seasons

The grey line arrows as shown in Figure 3 represent the direction of the Great Attractor, with Galactic coordinates $(l = 307^0, b = 9^0)$. The white circles represent the orbit of the Sun in the Milky Way, where the Sun moves clockwise. The black crosses divide the Sun's orbit in the Milky Way into four zones of 60 million years each. These represent the spring, summer, autumn and winter of the galactic year. The white arrows mark the position of the solar system in the Milky Way at the time of the five biological mass extinctions in Earth's history.

A:Ordovician－Silurian extinction events(450-440 million years ago)

B:Late Devonian extinction(375-360 million years ago)

C:Permian－Triassic extinction event（252 million years ago）

D:Triassic－Jurassic extinction event（201.3 million years ago）

E:Cretaceous－Paleogene extinction event （65 million years ago）

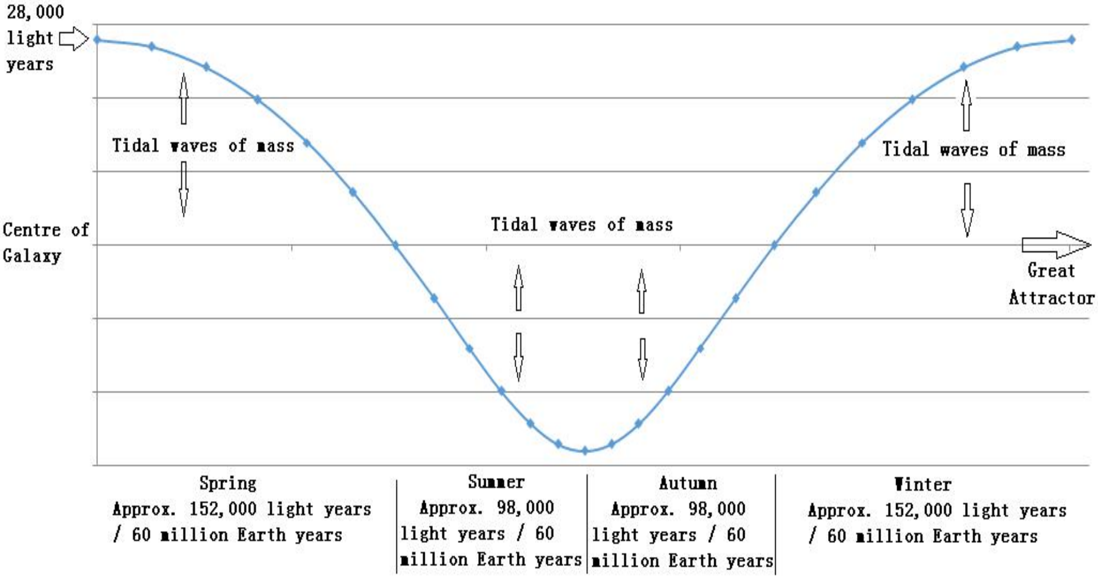

Fig.4.The trajectory of the solar system as observed in the inertial system at infinity

Figure 4 is a composite diagram of the trajectory of the solar system as observed in the inertial system at infinity, where the trajectory of the solar system is a composite of two motions: A) the motion of the solar system around the centre of the galaxy B) the galaxy in free-fall motion towards the great attractor. Relative to the inertial system at infinity, the Galactic year is characterised by periods of deceleration in spring and summer and acceleration in autumn and winter. The tidal waves of mass caused by changes in the gravitational pull of the Galactic centre also change significantly in each season of the Galactic year.

We believe that the five biological mass extinctions in Earth's history were directly caused by: A) a significant change in the tidal waves of mass acting on the solar system. B) a significant change in the speed of motion of the entire solar system relative to the inertial system at infinity. Both of these causes caused dramatic changes in the environment on Earth, or caused asteroids in the solar system to break away from their original orbits and impact the Earth.

We know that the Earth's rotation is slowed down for a long time due to the slowing down effect of factors such as the tides of the Sun and Moon. However, astronomical observations show that there is a 'non-tidal factor'[23][24] in the variation of the Earth's rotation speed that accelerates the Earth's rotation, and scientists still do not know what this 'non-tidal factor' is. We believe that the change in the Sun's orbit around the Galactic centre, which reduces the Earth's mass, is the 'non-tidal factor' that is causing the Earth to rotate faster. Monitoring data shows that the Earth's rotation speed is increasing. This 'non-tidal factor' that is accelerating the Earth's rotation is strengthening. Figure 5 shows the length-of-the-day (LOD) data curves published by the International Earth Rotation Service (IERS 2020) for the years 1962-2022.

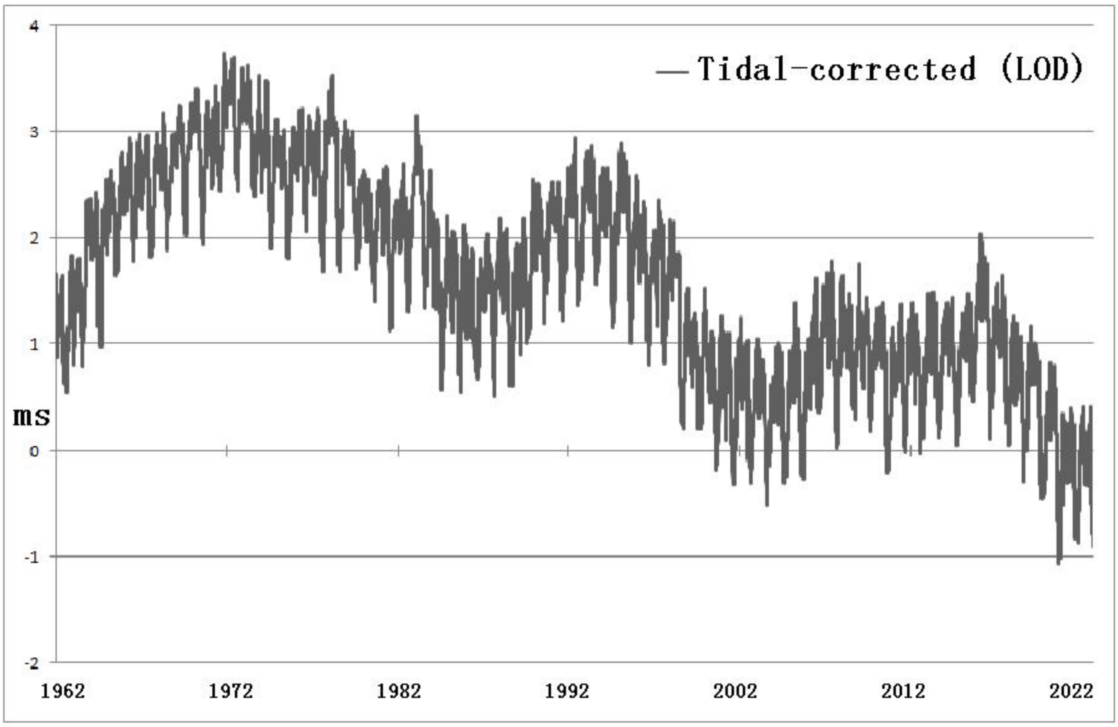

Fig.5. The LOD series from the IERS

As shown in Figure 5, there is a clear tendency for the Earth's rotation speed to accelerate in defiance of the decelerating effect of the solar and lunar tides, suggesting that the 'non-tidal factors' that make the Earth's rotation speed faster are intensifying. The Earth's rotational length of day (LOD) curve illustrated in Figure 5 is the result of the combined superposition of the following three effects. a) A tidal wave of mass caused by changes in the gravitational pull of the Galactic centre. b) A tidal wave of mass caused by changes in the gravitational pull of the Galactic plane. c) A tidal wave of mass caused by changes in the gravitational pull of the Sun.

We estimate that the Earth's rotation will continue to accelerate in the future. We believe that the acceleration of the Earth's rotation has a relatively large impact on all aspects of the planet, one of the more obvious effects being the change in the Earth's climate. Under the gravitational driving effect, the gas molecules of the subtropical high-pressure air masses near the Earth's equator gain higher velocities of motion, allowing the subtropical high-pressure expansion to cover higher latitudes. The global climate will become hot and arid(The relationship between the Earth's rotation and climate has been discussed extensively [25][26] and will not be discussed in detail here). In the future, when the Earth's mass stops decreasing, there will be a jump in the Earth's mass under the influence of tidal waves of mass from Great Attractor. We believe that the rapid change in the Earth's mass will have a huge impact on the planet and that the survival of humanity will be severely tested.

6 Conclusion

We know from the above discussion that in the real universe, inertial systems can only exist at some point in space or approximately in some local space. Since each spatial point in the gravitational field or rather each local inertial system has a different measuring rod and clock, we can deduce that the same object has different masses in different local inertial systems (or at different spatial and temporal points in the gravitational field) according to special relativity. In this way we use the equivalence principle to derive the conclusion that the mass of an object in a gravitational field follows the strength of the gravitational force. We hope to use more experiments to test that the mass of a macroscopic object in a gravitational field changes in accordance with equation (10).

Changes in the mass of an object in a gravitational field (gravitational drive effect) have an effect on all physical experiments in the gravitational field. In particular, measurement experiments in which the value of the universal gravitational constant G is measured in a gravitational field are most significantly affected. The accuracy of the G-value of the universal gravitational constant is the worst compared to other physical constants [27][28]. The reason for this is that all experiments that have measured the value of the universal gravitational constant G on Earth so far have not taken into account the influence of the changes in the gravitational field of the Moon, the Earth, the Sun or the Galactic Center on the experiment.

Therefore all physical experiments done in gravitational fields involving the mass of matter or particles should take into account the changes in mass, momentum, and energy of matter or particles under the influence of the gravitational field of the Moon, Earth, Sun, or Galactic Center in an integrated manner. For example, the muon anomalous magnetic moment experiment at Fermilab [29] should also consider the effect of changes in the gravitational field on the trajectory of the particle. In addition physicists should consider how to redefine the mass of objects in the gravitational field, and the total mass and energy of the universe and the mass of dark matter need to be recalculated. In the future, with the new theory of gravity as a basis, we can build a whole new cosmology that will give us a much deeper understanding of how the universe works.

In addition, in astronomy, we need accurate measurements of large amounts of astronomical data in order to calculate more accurately the magnitudes and curves of the Earth's mass changes, and we need the collaboration of scientists from various fields of expertise in order to assess more accurately the impact on the Earth of changes in the mass of the solar system and the Earth. We therefore need international cooperation to address the challenges posed to humanity by the universe.

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