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A New Perspective on Time and Gravity

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Abstract

This paper presents a hypothesis regarding the existence of time fused in spacetime, assuming that time possesses the properties of both a particle and a field. This duality is referred to as the field-particle of time (FPT). The analysis shows that when the FPT moves through matter, it causes time dilation. The FPT is also a significant element that appears in relativistic kinetic energy ($KE = (\gamma - 1) \cdot mc^2$). Accelerating matter to near the speed of light requires relativistic energy approaching infinity, which corresponds to the relativistic kinetic energy. Meanwhile, the potential energy ($PE = mc^2$) from the rest mass remains constant. Then, the mass-energy equation can be rearranged in terms of PE and KE, as shown in $E = (1 + (\gamma - 1)) \cdot mc^2$. The relativistic energy of the FPT also directly affects the gravitational attraction of matter. It transfers energy to each other through spacetime. The analysis demonstrates that the gravitational force is inversely proportional to the distance squared, following Newton's law of gravity, and it varies with the relative velocity of matter. The relationship equation between relative time and the gravitational constant indicates that a higher intensity of the gravitational field leads to a slower reference time for matter, in accordance with the general theory of relativity. A thought experiment presents a comparison of two atomic clocks placed in different locations. The first one is placed in a room temperature, around 25˚C, on the surface of the Earth, and the second one is placed in high-density areas. The analysis, considering the presence of the FPT, shows that the reference time slows down in high-density areas. Therefore, the second clock must be noticeably slower than the first one, indicating the existence of the FPT passing through both atomic clocks at different speeds.

Keywords

Field-Particle of Time (FPT), Reference Time, Relativistic Mass and Energy of

FPT, Gravity

1. Introduction

Time is one of the most mysterious fundamental concepts on physics in the universe. Philosophers and scientists have been studying the nature of time, developing theories and models to explain its properties and behaviors for many centuries. It is able to describe various relationships between events and time, indicating age, time intervals, the duration of movement from one position to another, etc. Moreover, it is known that time continuously moves forward in the direction indicated by the arrow of time, relating to the second law of thermodynamics stating that entropy increases over time [1] [2] [3]. This leads to the emergence of the past, present, and future.

Galileo has established fundamental knowledge in physics and astronomy through the observation of the motion of objects and celestial bodies. He believed that time is a universal quantity that can be measured and is a fundamental part of motion. Additionally, Galileo proposed the concept of the motion of objects with constant velocity, which will continue at that speed unless acted upon by an external force. The knowledge of time and motion developed by Galileo led to Newton's laws of motion [4] [5] [6] [7]. Newton stated that time is an absolute value that flows uniformly throughout the universe, regardless of any physical changes. Time is also the fundamental constant of the universe used to describe the motion of objects in space, which can be measured accurately. Furthermore, it has a connection with space and gravity, which later developed into the theory of gravity and the gravitational constant [8] [9] [10].

However, Einstein proposed the special theory of relativity, which shows that time is not an absolute value that is universally constant, but rather a relative value that depends on the velocity relative to the observer's frame of reference, according to the Lorentz factor [11] [12]. If an observer moves at high speeds or resides in a high gravitational field, their time will appear to pass slower compared to observers who move at slower speeds or reside in lower gravitational fields [13] [14] [15]. Then, Einstein presented the general theory of relativity, which explains that the force of gravity is a result of the curvature of spacetime caused by the presence of matter and energy [16] [17] [18]. Spacetime is a concept that Hermann Minkowski proposed by combining time and space into a single entity [19]. This concept is crucial for a better understanding of time and serves as a fundamental basis for Einstein's successful development of the theory. In addition, the general theory of relativity also indicates that an object located near a region of high gravitational field strength will experience a slower passage of time. This phenomenon is highly surprising in the aforementioned relationship. Despite scientist's continuous establish for profound knowledge all of time, there is still no definitive answer to the question, "What is time?". Therefore, understanding the true nature of time remains a key to unlocking the mysteries of nature, from the atomic level to the universe.

This paper presents the concept of the existence of time in spacetime, assuming that time possesses the properties of both a particle and a field, referred to as the field-particle of time (FPT). The analysis employs the particle perspective to illustrate its interaction with matter and the field perspective to depict the transmission of energy that affects gravitational forces. The existence of the FPT influences the flow of time in stationary or moving matter, as well as mass-energy and gravitational forces. Section 2 analyzes time phenomena that can either slow down or speed up based on the velocity of objects, from the perspective of observers, in accordance with the special theory of relativity. The analysis, utilizing the existence of the FPT to observe object motion instead of observers, yields the same effect as explaining it with the motion of a light clock. Section 3 demonstrates the relationship between mass-energy, where energy increases with the velocity of the object in relation to the Lorentz factor. The increased energy is a result of the object's relativistic kinetic energy, which is equivalent to the opposing force generated by the relativistic energy of the FPT.

Section 4 illustrates the analysis of gravitational force and the mechanism of gravitational attraction between objects. The gravitational force is a direct result of the interaction of the relativistic energy of the FPT passing through each other in spacetime, resulting in the force of attraction. Furthermore, it also explains the relationship between time, density, and gravitational force. Section 5 explains the concept of thought experiments to prove the existence of the FPT. Finally, in Section 6 provides a summary and comprehensive discussion of ideas related to the FPT, various connections to physical and natural phenomena to confirm the existence of the FPT.

2. Special Theory of Relativity with FPT Observation

Time and space is one entity which is inseparable well known as spacetime. If we consider the definition of spacetime and analyze it deeply when time exists, it raises the question of how time behaves and affects the object. In this section, we will analyze and describe the time behavior of objects that vary depending on velocity. We will consider the characteristics of the motion of light within a light clock from the perspective of an observer, comparing it with the perspective that assumes time as a particle that exists in spacetime and interacts with objects.

2.1. The Analysis of Special Theory of Relativity with the Light Clock Motion

To understanding the concept of time dilation and length contraction of special theory of relativity is clearly. We will start considering the motion of light clock as shown in **Figure 1**.

Figure 1(a) shows a cylindrical light clock with a vacuum inside. It has a light source and a mirror at the top and bottom. When the light hits the mirror, it immediately reflects back without any loss or delay. The length of the light clock

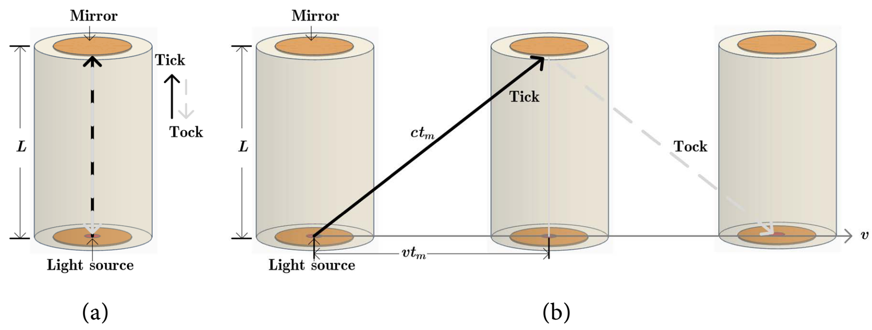

Figure 1. Light clock observation (a) light clock in stationary and (b) light clock in motion.

is L meters. In the initial state, the light clock is stationary. An observer will see the light beam of the light clock moving up and down inside the cylinder at the speed of light. The time of the light beam can be determined as follows:

$$t_s = L/c \tag{1}$$

where t_s is time of the light beam motion in the cylinder at rest, c represents the speed of light, which is equal to 3×10^8 m/s. When the light clock moves to the right with a constant velocity, which is equal to v, an observer will see the light beam moving diagonally upwards and downwards compared to the direction of motion, as shown in **Figure 1(b)**. This completes one cycle of the light beam of the light clock (tick-tock). From the observer's perspective, they will observe the stretching of the length of the light beam, which is described by the Pythagorean theorem as follow

$$L^2 + (vt_m)^2 = (ct_m)^2 \tag{2}$$

$$L^2 = c^2 t_m^2 \cdot \left[1 - (v/c)^2\right] \tag{3}$$

where t_m is the relative time of a moving light clock, we can find the relationship between the relative time of the light clock and its velocity as given by

$$t_m = \frac{L/c}{\sqrt{1-(v/c)^2}} = \frac{t_s}{\sqrt{1-(v/c)^2}} = \gamma t_s \tag{4}$$

where γ represents the Lorentz factor shown as

$$\gamma = \frac{1}{\sqrt{1-(v/c)^2}} \tag{5}$$

The Equation (4) explained that when the light clock is at rest, time of the light clock is equal to t_s. When the light clock is in moving, it causes the time dilation as t_m (longer tick-tock periods). This implies that the time of the light clock slows down. Additionally, if the light clock moves at the speed of light, relative time of the light clock becomes infinite, indicating that no time occurring with the light clock at all. This phenomenon demonstrates that the time of an object at rest and in motion will have different values. This is a highly surprising concept, as there was a previous belief that time is universally constant according to Newtonian concepts.

2.2. The Analysis of Special Theory of Relativity with the FPT Observation

In this analysis, we will assume that the FPT serves as an observer in various reference frames. The FPT is assumed to be smaller than any particle in the universe, transparent, moving in a vacuum at the speed of light, and uniformly blended with space to form spacetime. Spacetime has a three-dimensional shape with infinite dimensions of width, length, and height [20]. At every point in spacetime, the density of the FPT is the same, making it impossible to distinguish differences. Thus, we can consider the FPT as a one-dimensional entity existing in three-dimensional of space. All matter and objects exist within spacetime and are influenced by the FPT entirely.

The analysis begins by defining a frame of reference that spacetime is an infinite emptiness, devoid of matter, energy, force, or any other interacting fields. Additional properties will be assigned to the spacetime as follows:

1) Space must coexist with the FPT to maintain the characteristic of spacetime and cannot be permanently isolated from it.

2) Matter and energy present in every position of spacetime cause the curvature and wrapping of space around them. The FPT will flow into the interior, including into every empty position within them.

3) The space that curves and wraps around matter and energy will be filled by the surrounding FPT to maintain the original characteristics of spacetime.

4) The speed of FPT in a vacuum is equal to the speed of light, but it decreases when moving within high densities of matter and energy, due to the friction of them.

Based on the characteristics and properties of the hypothetical spacetime mentioned above, it can be observed that in the initial state, before the existence of any matter and energy, only FPT exist in spacetime. When matter arises, it causes spacetime to curve and wrap around the matter. Meanwhile, FPT move into the matter and cause time to be referenced to that matter. To facilitate understanding, it is assumed that the mass, size, and density of the matter approach zero, and FPT only move from the forward direction (v_{tf}) and the reverse direction (v_{tr}) in relation to the direction of the matter, as shown in **Figure 2**.

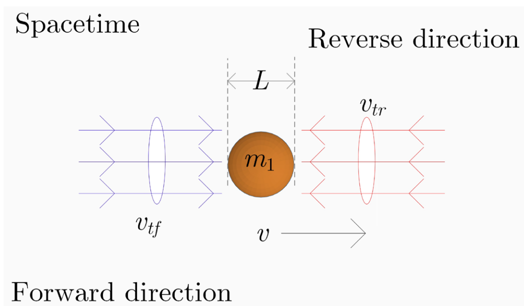

Figure 2. The matter and motion of the FPT in spacetime.

From **Figure 2**, we will first consider the case where the matter is at rest. The FPT will move into the matter with the speed of motion equal to $v_{tf} = v_{tr} = v_{tm}$, which is equal to the speed of light. This relationship can be expressed by the equation

$$v_{tm}t_{obj} = ct_{obj} = L \tag{6}$$

where t_{obj} represents the time taken by FPT as they move through the matter. It is equal to

$$t_{obj} = L/c \tag{7}$$

It is noteworthy that the value is equal to t_s, as shown in Equation (1). When matter is in motion at the speed of v, the relationship can be found according to the relative velocity of matter and FPT as follows:

$$\left(v_{tr} + v\right)\cdot t_r = L \tag{8.1}$$

$$\left(v_{tf} - v\right)\cdot t_f = L \quad (8.2).$$

where t_f and t_r represent the time for the motion of FPT through matter in the forward and reverse directions, respectively. Therefore, the Equations (8.1) and (8.2) can be rewritten as

$$\left(c + v\right)\cdot t_r = L \tag{9.1}$$

$$\left(c - v\right)\cdot t_f = L \quad (9.2).$$

Multiply Equation (9.1) by Equation (9.2) which are shown as

$$\left(c + v\right)\cdot\left(c - v\right)\cdot t_f t_r = L^2 \tag{10.1}$$

$$c^2\cdot\left(1 - \frac{v^2}{c^2}\right)\cdot t_f t_r = L^2 \tag{10.2}$$

From the Equation (10.2), we can show as

$$t_f t_r = \frac{\left(L/c\right)^2}{1 - \left(v/c\right)^2} \tag{11}$$

Taking the square root of Equation (11), we get that

$$\sqrt{t_f t_r} = \frac{L/c}{\sqrt{1 - \left(v/c\right)^2}} = \gamma t_s = t_m \tag{12}$$

From the Equation (12), it can be observed that the result is equal to the special theory of relativity according to Equation (4). This implies that there may exist a real interaction between the FPT and matter in spacetime, leading to the emergence of a reference time for the matter and causing a time-dilation depending on the relative velocity.

3. The Complementary of Mass-Energy Equation from the Existence of FPT

The mass-energy equation is the famous equation of Einstein [21] which is important in physics. The equation shows that mass and energy can transform each other according to

$$E = \gamma m_0 c^2 = m_{\text{rel0}} c^2 \tag{13}$$

where E is relativistic energy, m_0 is rest mass and m_{rel0} is relativistic mass of m_0. Considering the Equation (13) and Equation (5), the relativistic mass of matter will be infinitely large when it is accelerated to the speed of light. This means that it is impossible to accelerate matter to the speed of light because an infinite amount of energy would be required to achieve such acceleration.

From the experiment at CERN to accelerate proton to near the speed of light and collides them with another proton in the Large Hadron Collider (LHC), the results of the collision led to the discovery of a new particle known as the Higgs-Boson [22]. It is surprising that in several experiments at CERN, there have been no indications that the mass of proton approaches infinity as predicted by Equation (13).

In this section, an analysis will be presented to find an explanation that corresponds to the phenomenon observed from the experimental results of CERN as mentioned above. By assuming the properties and characteristics of FPT same as the previous section, we can demonstrate an analysis to find the correlation between the relativistic mass and mass of FPT by considering the momentum of matter, as shown in **Figure 3**.

Figure 3 shows the perspective of momentum of matter. When matter moves through spacetime with a constant velocity of v, the FPT will move into the matter from the forward and reverse direction with the velocity of v_{tf} and v_{tr} respectively, which is equal to the speed of light. We can express the momentum equation as

$$m_f \cdot (v + c) - m_r \cdot (v - c) = \gamma m_1 v = m_{\text{rel1}} v \tag{14}$$

where m_1 is rest mass, m_{rel1} is relativistic mass of m_1, m_f and m_r are mass of FPT from forward and reverse direction, respectively. From Equation (14), it can be rearranged as

$$(m_f - m_r) \cdot v + \left[(m_f + m_r) \frac{c}{v} \right] \cdot v = m_{\text{rel1}} v \tag{15.1}$$

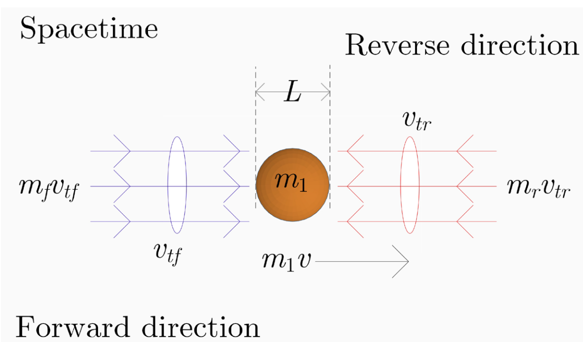

Figure 3. Motion and momentum of matter.

$$\left[\underbrace{\left(m_f - m_r\right)}_{m_1} + \underbrace{\left(m_f + m_r\right)\frac{c}{v}}_{m_t}\right] \cdot v = m_{\text{rel1}} v \tag{15.2}$$

where m_t represents the relativistic mass of FPT included in the relativistic mass of m_1. We can obtain m_f and m_r from the equations

$$m_f = \frac{m_{\text{rel1}}\left(1-\left(1/\gamma\right)\right)}{\gamma - 1} \cdot \left[1 + \frac{1}{2} \cdot \left[\frac{v}{c}\left(\gamma - 1\right) - 1\right]\right] \tag{16.1}$$

$$m_r = \frac{m_{\text{rel1}}\left(1-\left(1/\gamma\right)\right)}{2} \cdot \left(\frac{v}{c} - \frac{1}{\gamma - 1}\right) \tag{16.2}$$

From the Equation (15.2), it can show that the relativistic mass consists of two elements as follow

$$\begin{aligned} m_{\text{rel1}} &= m_1 + m_t \\ &= \left(1 + \left(m_t/m_1\right)\right)m_1 = \gamma m_1 \end{aligned} \tag{17}$$

Therefore, the Lorentz's factor can express in term of

$$\gamma = 1 + \left(m_t/m_1\right) \tag{18}$$

and m_t can be obtained from the equation

$$m_t = \left(\gamma - 1\right)m_1 \tag{19}$$

Considering Equation (19), it is found that the relativistic mass of FPT varies with the product of rest mass (m_1) and term of ($\gamma - 1$), which is related to velocity in motion. If matter approaches the speed of light, it causes the relativistic mass of FPT to approach infinity. Considering the mass-energy relationship, it can be demonstrated that

$$E = \gamma m_1 c^2 \tag{20}$$

Refer to the Equation (17), the Equation (20) will be shown as

$$E = \left(m_1 + m_t\right)c^2 = \left(1 + \left(m_t/m_1\right)\right)m_1 c^2 \tag{21}$$

Replacing m_t in the Equation (21), the mass-energy equation can be rearranged to

$$E = \underbrace{m_1 c^2}_{\text{PE}} + \underbrace{\left[\left(\gamma - 1\right)m_1\right]c^2}_{\text{KE}} \tag{22.1}$$

$$\text{PE} = E_{m1} = m_1 c^2 \tag{22.2}$$

$$\text{KE} = E_{mt} = \left(\gamma - 1\right)m_1 c^2 \tag{22.3}$$

Considering the mass-energy equation in (22), it is found that the relativistic energy of matter is composed of the potential energy (PE) from rest mass and the relativistic kinetic energy (KE) from the relative motion of matter, which is equivalent to the relativistic energy of FPT.

Figure 4 illustrates the normalize energy (E/m_1c^2) components of matter relative to the ratio of v/c. In **Figure 4(a)**, potential energy is related to the rest mass,

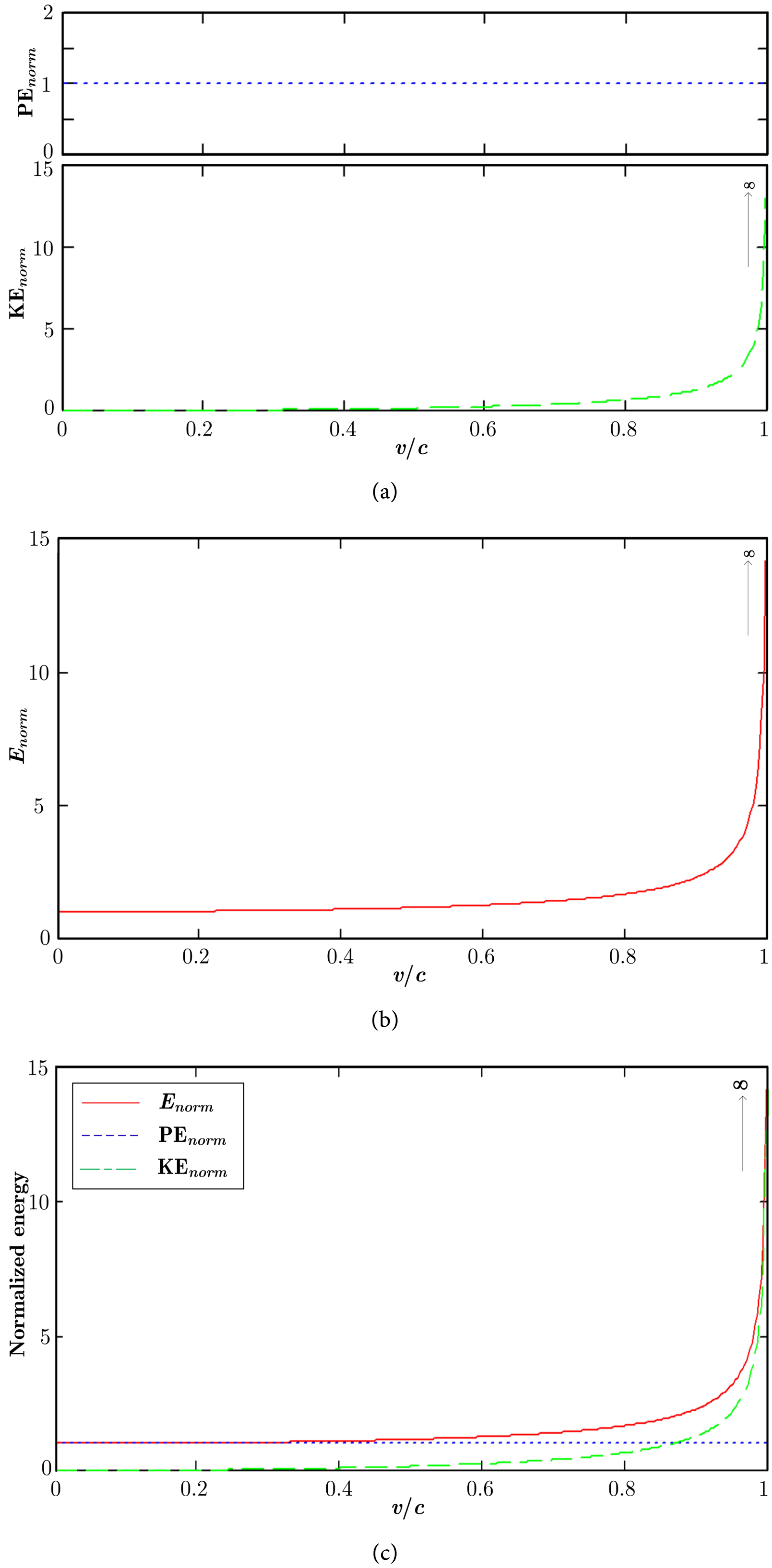

Figure 4. Composition of the normalize energy versus the ratio of v/c: (a) Potential energy and relativistic kinetic energy, (b) Relativistic energy of matter and (c) Energy components.

and the relativistic kinetic energy is related to the relativistic mass of FPT. From the graph, it can be observed that potential energy remains constant and unchanged with velocity, indicating a constant rest mass. However, the relativistic kinetic energy varies with speed and approaches infinity when matter moves at the speed of light. The relativistic energy of matter varies according to the relativistic kinetic energy, as depicted in **Figure 4(b)**. In **Figure 4(c)**, a comparison of energy components as mass-energy constituents of matter is presented. In the case of matter is stationary, the relativistic energy of matter is only the potential energy. When the matter is in motion, relativistic kinetic energy is arising and vary to its relative velocity. Meanwhile, the rest energy remains constant. The relativistic kinetic energy occurred will be equal to the relativistic energy of FPT. When the matter is accelerated to the speed of light, the relativistic kinetic energy becomes infinite, causing the energy of the matter to also become infinite.

If we profoundly consider in **Figure 3**, it can be observed that accelerating matter by increasing the relativistic kinetic energy will result in an opposing force equal to the relativistic energy of FPT according to Newton's third law of motion. It is worth noting that the potential energy is constant, but the increase in the energy of matter is solely due to the relativistic kinetic energy. **Figure 4** can explain what happens in CERN's experiment, summarizing that to accelerate the matter to near the speed of light requires an enormous amount of energy to overcome the opposing force generated by the relativistic energy of FPT, while the rest mass remains unchanged.

4. Gravity

4.1. Mechanism of Gravity's Work

Gravity is one of the most important phenomena in the universe that scientists have been trying to understand and explain for a long time. It causes matter to bind, revolve, and orbit around each other, from the smallest atomic level to the largest stellar level. Newton discovered the relationship between objects falling from a height and formulated the law of gravity, which is expressed as the equation

$$F = Gm_1m_2/r^2 \tag{23}$$

where G is the gravitational constant referenced to the Earth, which is equal to 6.674×10^{-11} ($m^3/Kg \cdot s^2$). m_1 and m_2 are the mass of two bodies and r is the distance between the center of mass of m_1 and m_2 in meter. However, Newton still couldn't understand what exactly this force was. Einstein provided an interesting perspective and explanation of gravity. He stated that gravity is the curvature of spacetime and the embrace of object, causing them to attract together. This theory, known as the general theory of relativity, is described by

$$G_{uv} = 8\pi GT_{uv}/c^4 \tag{24}$$

where G_{uv} is Einstein tensor and T_{uv} is the energy-momentum tensor.

In this section, we will explain the actual mechanism that gives rise to the force of gravity between objects, using the assumption of the existence and motion of FPT through spacetime. The analysis will utilize the property of being a field for ease of understanding. Based on the hypotheses described in the previous section and the complementary mass-energy equation from FPT according to Equation (22), it shows that the relativistic kinetic energy is equivalent to relativistic energy of FPT, which is from m_t.

When considered carefully, it can be found that the motion of FPT causes the transmission of energy, which directly affects the gravitational force between objects. We can explain the mechanism of the gravitational force from Figure 5.

From Figure 5, objects of mass m_1 and m_2 are separated by a distance r. Both objects move with the same velocity, v. In the analysis, it is assumed that no other energy or force acts upon the objects. Considering the intensity of the relativistic energy of FPT at the center of mass m_1, which extends to the center of mass m_2 (E_{21}), and vice versa, the intensity of the relativistic energy of FPT at the center of mass m_2, which extends to the center of mass m_1 (E_{12}), it can be demonstrated that

$$E_{21} = -\frac{E_{\mathrm{mt1}}}{4\pi r_1^2 \alpha_1^2} \cdot \pi r_2^2 \tag{24.1}$$

$$E_{12} = -\frac{E_{\mathrm{mt2}}}{4\pi r_2^2 \alpha_2^2} \cdot \pi r_1^2 \tag{24.2}$$

where E_{mt1} and E_{mt2} are the relativistic energies of FPT for m_1 and m_2, respectively, which are equivalent to the relativistic kinetic energy shown in Equation (22.3). The negative sign indicates the direction of energy moving away from the center of mass. r_1 and r_2 represent the radii of m_1 and m_2, respectively, while $\alpha_1 = r/r_1$ and $\alpha_2 = r/r_2$ are the ratios of the distance between the objects and the radius of m_1 and m_2, respectively. In a state of gravitational equilibrium, the forces acting upon each other are equal in magnitude. From Equation (24), it can be shown that

$$-\frac{E_{mt1}}{4\pi r_1^2 \alpha_1^2} \cdot \frac{\pi r_2^2}{2r_2} + \frac{E_{mt2}}{4\pi r_2^2 \alpha_2^2} \cdot \frac{\pi r_1^2}{2r_1} = 0 \tag{25}$$

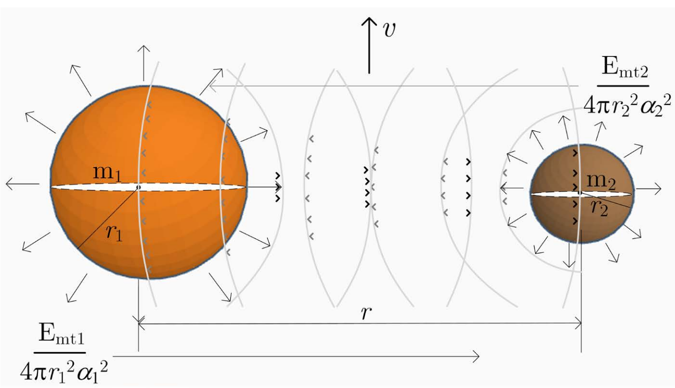

Figure 5. Mechanism of gravity between objects.

By substituting the value of E_{mt1} and E_{mt2} into Equation (25), it can be shown as

$$-\frac{(\gamma-1)m_1\cdot c^2}{8r_1^2\alpha_1^2}\cdot r_2+\frac{(\gamma-1)m_2\cdot c^2}{8r_2^2\alpha_2^2}\cdot r_1=0 \tag{26.1}$$

$$\frac{(\gamma-1)\cdot c^2}{8}\cdot\left(-\frac{m_1\cdot r_2}{r_1^2\alpha_1^2}+\frac{m_2\cdot r_1}{r_2^2\alpha_2^2}\right)=0 \tag{26.2}$$

From the Equation (26), it can be derived to

$$\frac{(\gamma-1)\cdot c^2}{8}=0;\ @\, v=0 \tag{27.1}$$

$$\left(-\frac{m_1\cdot r_2}{r_1^2\alpha_1^2}+\frac{m_2\cdot r_1}{r_2^2\alpha_2^2}\right)=\left(-\frac{m_1\cdot r_2}{r^2}+\frac{m_2\cdot r_1}{r^2}\right)=0 \tag{27.2}$$

Therefore, the relationship between mass and distance at equilibrium is obtained as follows:

$$\frac{m_2}{m_1}=\frac{r_2}{r_1}=\frac{\alpha_1}{\alpha_2} \tag{28}$$

Equation (28) shows the equilibrium gravitational force with respect to the mass ratio and radius ratio of two bodies. From the Equations (25) and (28), we can show that

$$\begin{aligned}|F_{21}|=|F_{12}|=F_g&=\frac{(\gamma-1)m_1\cdot c^2}{8r_1\alpha_1^2}\cdot\frac{m_2}{m_1}\\&=\frac{(\gamma-1)\cdot c^2}{8(m_1/r_1)}\cdot\frac{m_1\cdot m_2}{r^2}\end{aligned} \tag{29}$$

In the Equation (29), it is equivalent to the gravity from Equation (23), which is shown as

$$F_g=\underbrace{\frac{(\gamma-1)\cdot c^2}{8(m_1/r_1)}\cdot\frac{m_1}{r^2}}_{g}\cdot\underbrace{m_2}_{m}=G\cdot\frac{m_1\cdot m_2}{r^2} \tag{30}$$

Equation (30) demonstrates that the gravitational force is equivalent to the force described by the equation $F = mg$, where the gravitational constant can be expressed in relation to the equation as follows:

$$G=\frac{(\gamma-1)\cdot c^2}{8(m_1/r_1)}=\frac{(\gamma-1)\cdot c^2}{8(m_{\text{E}}/r_{\text{E}})} \tag{31}$$

where $m_{\text{E}}/r_{\text{E}}$ represents the ratio of mass to the radius of Earth. When considering Equation (31) comprehensively, it becomes apparent that the value of the gravitational constant varies with the relative velocity of the Earth in relation to the Lorentz factor. However, since the Earth has a relatively constant velocity over the elapsed time, the value of the gravitational constant can still be approximated as 6.674×10^{-11} ($\text{m}^3/\text{kg}\cdot\text{s}^2$) without changing.

We can calculate the Earth's speed of motion using the relationship of the Lorentz factor in Equation (31), which is approximately equal to 31 Km/s. This value is similar to the orbital speed of Earth around the Sun, which is approximately 30 Km/s. Additionally, the Earth's self-rotating speed is 400 m/s. Using Equations (30) and (31), we can express the gravitational acceleration of Earth as follows:

$$g_{\mathrm{E}} = \frac{(\gamma - 1)\cdot c^2}{8(m_{\mathrm{E}}/r_{\mathrm{E}})}\cdot\frac{m_{\mathrm{E}}}{r^2} = \frac{(\gamma-1)\cdot c^2}{8r_{\mathrm{E}}\alpha_{\mathrm{E}}^2} \tag{32}$$

The ratio $\alpha_{\mathrm{E}} = r/r_{\mathrm{E}}$ represents the distance over which gravitational acceleration extends from the center of Earth, divided by the radius of Earth. Based on the relationship presented in Equation (32), it can be illustrated in **Figure 6**.

Figure 6 shows the values of gravitational acceleration based on distance according to the relationship $g = Gm/r^2$, compared with the calculated values from Equation (32). It can be observed that the gravitational acceleration decreases and varies inversely with the square of the distance from the center of the Earth. The calculated gravitational acceleration on the Earth's surface from Equation (32) is approximately 9.42 m/s^2, which is close to the average measured value of 9.81 m/s^2.

4.2. The Relationship of Time, Density and Gravity

In this section, the relationship between gravitational attraction and relative time of an object is demonstrated in accordance with general theory of relativity, which states that time slows down when approaching a region of high gravitational field intensity. Considering the equation of the relative time of an object in motion according to Equation (12), it can be seen that the relative time changes with the speed of the object by the Lorentz factor and is also related to the relativistic mass of the FPT. According to Equations (18) and (19), we can rewrite the equation of relative time of objects as follows:

$$\begin{aligned} t_m &= \gamma t_s = \left(1 + \frac{m_t}{m_1}\right)\cdot t_s \\ &= \left(1 + \frac{(\gamma-1)\cdot m_1}{m_1}\right)\cdot t_s = \left(1 + (\gamma - 1)\right)\cdot t_s \end{aligned} \tag{33}$$

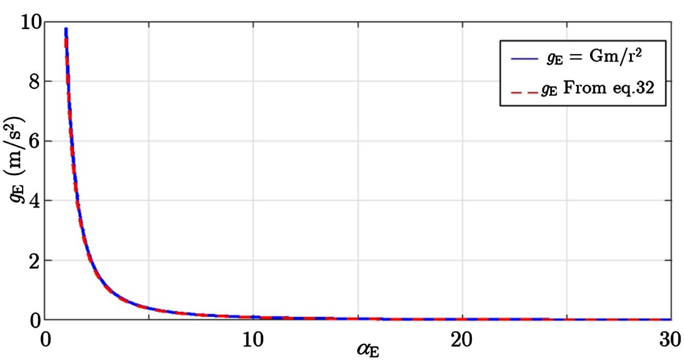

Figure 6. Comparing the values of gravitational acceleration based on distance.

By comparing Equation (31) with Equation (33), it becomes evident that the relative time and gravitational constant are related through terms involving (γ − 1), which represents the relative velocity of the object. Therefore, we can express the relationship between relative time and gravitational constant as

$$t_m = \left(1 + \left(\frac{4\rho_1 (r_1 c)^2}{3} \cdot \underbrace{8\pi G/c^4}_{G_{uv}/T_{uv}}\right)\right) \cdot t_s \tag{34}$$

where ρ_1 is mass density of m_1. In Equation (34), it is evident that relative time, gravity and mass density are related. As the intensity of the gravitational field increases, the relative time of the object will dilate, just like with high mass density, where the friction force of the object will decrease the velocity of FPT passing through it. This causes the relative time of the object to dilate, implying that the object's reference time slows down.

5. Thought Experiment

To prove evidence for the existence of FPT, it relies on the knowledge that humans have acquired through long-term observation, learning, and understanding of natural phenomena. When observing nature, it becomes evident that all objects and substances undergo deterioration and changes over time. Objects with low density deteriorate rapidly, while those with high density deteriorate slowly. Examples include steel, hardwood, stone, diamonds, etc. Likewise, the preservation of animal tissues, the freezing of sperm and similar practices in cold or sub-zero temperature environments aim to extend the stability of cells, slowing down the process of deterioration. In extremely cold temperatures, the air volume decreases, leading to an increase in density [23]. From the aforementioned observations, the relationship between the density and the deterioration time of an object or matter can be clearly seen. This implies that reference time for an object or matter slows down with increasing density. This is consistent with the explanation in the previous section that time slows down in dense objects.

The experiment to prove the existence of FPT and the slowing of time will begin by using two atomic clocks or high-precision clocks. The clocks will be accurately synchronized, ensuring no time deviation between them. Next, place both clocks in different locations to compare the passage of time. Place clock 1 in a room with normal room temperature, around 25˚C, on the surface of the Earth and place clock 2 in the following locations:

1) Place in a room with extremely cold temperatures or below freezing or,

2) Place in a box that is completely closed on all sides, which is made of high-density materials or,

3) Place in the underground lab.

Then, compare the time difference between both clocks, where clock 2 is expected to be slower than clock 1.

6. Conclusions

This paper presents the concept of the existence of FPT in spacetime. FPT and space are fused in spacetime and cannot be permanently separated. They move at the speed of light in a vacuum but experience a decrease in speed when passing through high density matter due to matter friction. The FPT passing through matter gives rise to a reference time of matter and can move slower or faster depending on the relative velocity between the matter and FPT. The analysis is based on the special relativity perspective of FPT, which is consistent with Einstein's special theory of relativity.

From the analysis of the mass-energy equation from the perspective of FPT, it is found that FPT is an important element that appears in the mass-energy equation. The relativistic energy of FPT is equivalent to the relativistic kinetic energy of matter. When matter moves at higher speeds, relativistic kinetic energy increases, and it becomes infinite as it approaches the speed of light. This is the reason why the mass-energy equivalence of matter also becomes infinite. The relativistic energy of FPT acts as if it opposes the motion of matter to prevent it from reaching the speed of light, which is consistent with Einstein's statement that it is impossible to accelerate matter to the speed of light. This is because it would require infinite energy to overcome the opposing force caused by the relativistic energy of FPT.

FPT also plays an important role in the gravitational attraction between matters. From the analysis, it is evident that the gravitational energy of FPT of matter extends in all directions around the matter, proportional to the energy intensity per unit area. They travel through spacetime at the speed of light towards the surrounding matter. The transmitted energy is then transformed into a gravitational force that varies with the inverse square of the distance, according to Newton's law of gravity. The analysis reveals the relationship between the gravitational field and the reference time of matter, consistent with the general theory of relativity, which states that the time of matter slows down when in proximity to a high gravitational field. Furthermore, it demonstrates that the density of matter affects the passage of FPT and causes a slowing down of the matter's time. Thought experiments will demonstrate the presence of FPT, which will undoubtedly slow down the clock's time.

Therefore, the true meaning of time can be defined as the reference to the changes of events, matter, energy, and everything that arises from the passage of FPT, which gives rise to the reference time for these things. However, for a mutual understanding of human perception, reference time is commonly referred to as time. Events that have occurred in the past, present, or will occur in the future are all references to the time that arises from the reference time. Nevertheless, since the human sensory system cannot perceive the passage of FPT, it is unable to accurately determine the specific reference time. Therefore, observations of natural phenomena are used to indicate time intervals, and subsequently, more precise timekeeping devices have been invented to provide accurate time references, and that is what we call a clock.

The theoretical analysis shows that the reference time, which occurs due to the FPT, is not an illusion. It interacts with everything and is involved in time dilation, mass-energy equation, and gravity.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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