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The Fourth Dimension of Time and Gravity

Ittipat Roopkom[1], Pichet Wisartpong[2], Wirote Jongchanachavawat[1], Beverly F. Stout[3], Tawatchai Mayteevarunyoo[4] & Paramote Wardkein[5]

[1] Faculty of Engineering and Industrial Technology, Phetchaburi Rajabhat University, Phetchaburi, Thailand

[2] School of Electrical and Electronic Engineering, Mahanakorn University of Technology, Bangkok, Thailand

[3] BME, and independent researcher, Delta State University, Cleveland, MS, USA

[4] Department of Electrical and Computer Engineering, Faculty of Engineering, Naresuan University, Phitsanulok, Thailand

[5] Department of Telecommunications Engineering, School of Engineering, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand

Correspondence: Ittipat Roopkom, Faculty of Engineering and Industrial Technology, Phetchaburi Rajabhat University, Phetchaburi, Thailand. Tel: 66-88-687-4777. E-mail: ittipat.roo@mail.pbru.ac.th

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Abstract

This article presents a novel perspective on understanding the nature of time through the proposition of a new elementary particle called 'Timeons.' Timeons are hypothesized to be integrated with space, forming a unified matter known as spacetime. Spacetime is conceptualized as a singular entity encompassing three spatial dimensions (width, height, and depth), which expand infinitely, alongside one dimension of time influenced by the presence of Timeons. When matter moves within spacetime along any trajectory, it catalyzes the manifestation of time at that specific point. Considering time on an axis, it behaves as a one-dimensional continuum progressing forward along the arrow of time. Analysis suggests that Timeons are intermediary particles that transfer energy through spacetime, converting it into gravitational force acting upon matter. This intrinsic nature of Timeons within spacetime delineates the experience of matter's time and exerts influence on gravitational forces affecting matter.

Keywords: Timeons, time, gravity, the fourth dimension

1. Introduction

Time is a mystery that scientists have been trying to understand for millennia. However, there is still no clear answer to this question. Galileo believed that time is a universal quantity of the universe that can be measured and is essential to motion. Newton expanded on Galileo's ideas and developed Newton's laws of motion (Henry, 2011; Hall, 1965; Capecchi, 2021; Motte, 1729), believing time to be an absolute quantity that is the same throughout the universe and is related to the motion of matter, which later evolved into the theory of gravity (Cavendish, 1798; Li *et al*., 2018). However, Einstein proposed the special theory of relativity, which showed that time is a relative quantity depending on the speed of observers and matter. Einstein further extended this concept to the general theory of relativity, explaining gravity as the curvature of spacetime due to the presence of matter and energy (Einstein and Minkowski, 1920; Robert, 2025; Landsman, 2021; Pokai-udom, 2011). The reliability of Einstein's theory was confirmed by observing the bending of light during the solar eclipse of 1919. While Einstein's general theory of relativity covers phenomena from the microscopic to the cosmic scale, Newton's theory of gravity remains useful in everyday life. With different perspectives on time and gravity, understanding the reality of time and gravity is key to unlocking the mysteries of the universe.

This article presents the hypothesis of the existence of fundamental particles called Timeons, which are particles that give rise to time in matter. Timeons possess properties of both particles and fields, which are fused into spacetime with four dimensions, three dimensions of space and one dimension of time. A deep understanding of all four dimensions can help us understand the mechanisms of time and the universe better. Section 2 will illustrate the hypothesis and the perspective of time as a single dimension hidden in the fourth dimension of the universe. Section 3 will demonstrate the relationship of Timeons and their interaction with matter, as well as the gravitational mechanism arising from the existence of Timeons. Section 4 will summarize the ideas and connections to physical and natural phenomena.

2. The Fourth Dimension Within Spacetime

Time is one dimension and the fourth dimension of spacetime. It is a concept that is deeper than we can easily comprehend. We can perceive one, two, and three dimensions, but we cannot perceive the fourth dimension. In this section, we will illustrate the perspective of the time dimension hidden within spacetime, resulting from Timeons. Spacetime is assumed to have a three-dimensional shape with infinite width, length, and depth (Yau and Nadis, 2010), and it is hypothesized that Timeons are smaller than any particle and are abundant in the universe, fused into spacetime to form a homogeneous fabric of spacetime. At every point in spacetime, there is a uniform density of Timeons, making it a one-dimensional aspect within three-dimensional space, as depicted in Figure 1.

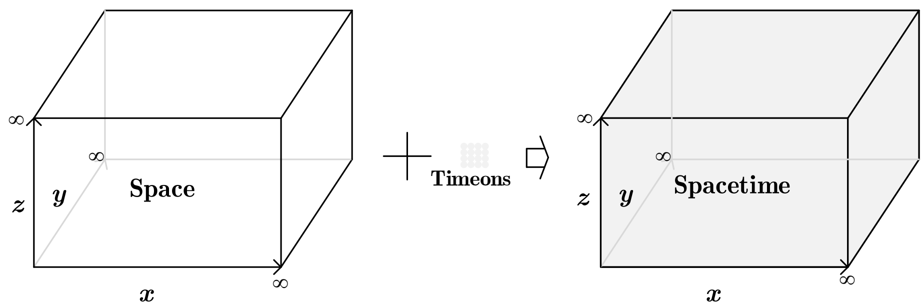


Figure 1. Timeon's perspective within spacetime

Figure 1 illustrates a new perspective of four-dimensional spacetime with Timeons integrated within spacetime, interacting with various types of matter present in spacetime. Additional properties attributed to spacetime are as follows:

1. Space must coexist with Timeons to maintain its spacetime characteristics, and they cannot be permanently separated.

2. The velocity of Timeons in a vacuum equals the speed of light but decreases when passing through matters and areas of high energy density.

3. Matter and energy cause spacetime to bend and wrap around them. Timeons will move into the matter, and space is replenished with surrounding Timeons to maintain its original spacetime characteristics.

Based on these proposed properties of spacetime, when matter occurs in spacetime, it interacts with Timeons, leading to the emergence of time within the matter, demonstrating the mechanism of time emergence as depicted in Figure 2.

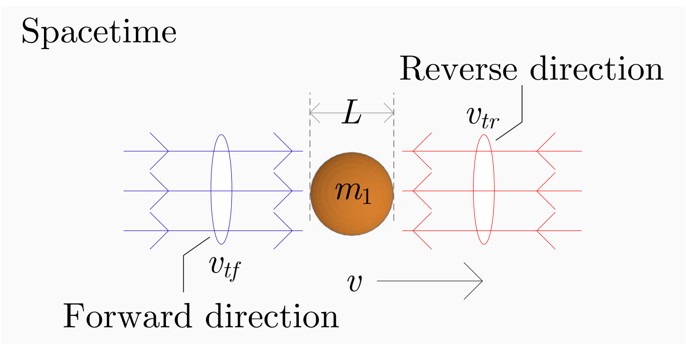


Figure 2. Timeons and matter interaction

From Figure 2, when matter is stationary, time is a field that moves through the matter in all directions. When the matter moves, we can determine the interactions with Timeons, depicted as follows:

$$\left(v_{tr}+v\right)\cdot t_{r}=L \tag{1.1}$$

$$\left(v_{tf}-v\right)\cdot t_{f}=L \tag{1.2}$$

Where v and L represent the velocity and size of the matter, while v_{tf}, v_{tr} and t_f, t_r represent the velocity and time taken for the matter to pass through Timeons in the same direction and opposite direction of the matter's motion, respectively. From equation (1), assuming the size of the matter is nearly zero and v_{tf}, v_{tr} move at the same speed as v_{tm}, it can be written as follows:

$$\left(v_{tm}+v\right)\cdot t_{r}=L \tag{2.1}$$

$$\left(v_{tm}-v\right)\cdot t_{f}=L \tag{2.2}$$

Multiply equation (2.1) with (2.2), then we can express the equation as follows:

$$\left(v_{tm}+v\right)\cdot\left(v_{tm}-v\right)\cdot t_{f}t_{r}=L^{2} \tag{3.1}$$

$$v_{tm}{}^{2}\cdot\left(1-\left(v/v_{tm}\right)^{2}\right)\cdot t_{f}t_{r}=L^{2} \tag{3.2}$$

$$t_{f}t_{r}=\left(L/v_{tm}\right)^{2}\Big/\left(1-\left(v/v_{tm}\right)^{2}\right) \tag{3.3}$$

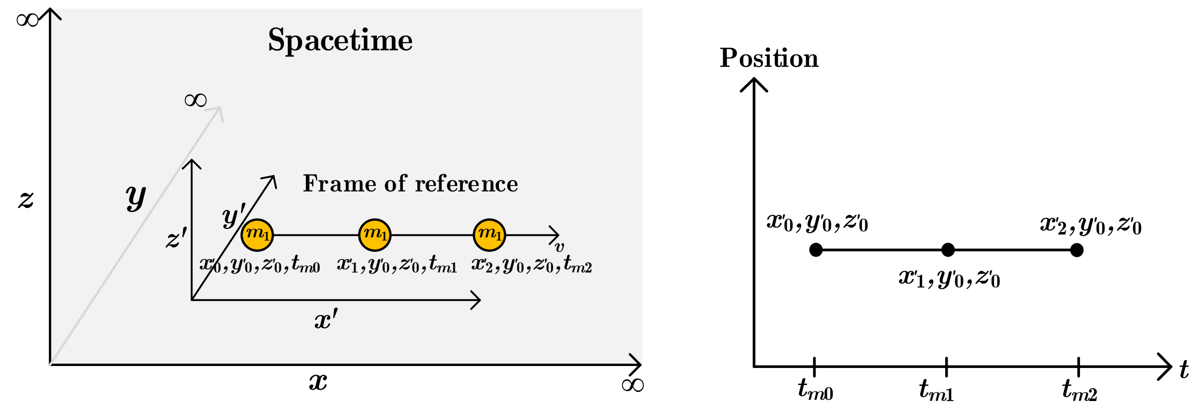
In the case where v_{tm} is the speed of light (c) in a vacuum, we can express the equation in terms of time dilation as follows:

$$t_{m}=\gamma t_{s}=\left(L/c\right)\Big/\sqrt{\left(1-\left(v/c\right)^{2}\right)} \tag{4}$$

Where t_s and t_m represent time of rest and motion of matter respectively, c represents the speed of light, which has a value of $3\cdot10^{8}$ m/s and γ is the Lorentz factor obtained from

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

After a meticulous review of equation (4), it becomes apparent that the time dilation of matter conforms to the special theory of relativity (Pokai-udom, 2010). This implies that 'Timeons' may exist in spacetime, influencing the observed time dilation based on the matter itself. We can illustrate the fourth dimension of time on a one-dimensional time axis, as shown in Figure 3.



(a) (b)

Figure 3. Matter in motion within spacetime (a) Moving to the right at constant velocity, and (b) Comparison of position and time of matter

From Figure 3 (a), we observe that matter, moving in spacetime to the right at a constant velocity v, passes through positions (x'_0, y'_0, z'_0), (x'_1, y'_0, z'_0) and (x'_2, y'_0, z'_0) at time t_{m0}, t_{m1} and t_{m2} respectively. We can then demonstrate the relationship between the motion of matter through various positions and the time axis, as depicted in Figure 3 (b). This figure clearly illustrates the one-dimensional aspect of time hidden within four-dimensional spacetime. Therefore, when matter exists in spacetime, Timeons will simultaneously be both field and particle and it moves through that matter, regardless of whether the matter is at rest or moving in any direction in spacetime.

3. Gravity

3.1 The Mechanism of Gravity (*Roopkom et al., 2024*)

In this section, we will demonstrate the analysis of the mechanism behind the gravitational force between masses. When matter moves, it generates relativistic kinetic energy, which is equivalent to the relativistic energy of Timeons. This energy creates resistance to the motion of matter, in accordance with Newton's third law of motion, preventing matter from moving at the speed of light. We can calculate the relativistic kinetic energy from the motion of matter using the equation:

$$\mathrm{KE} = (\gamma - 1) \cdot mc^2 \tag{6}$$

where m represents the mass of matter in kilograms. The force from the interaction between matter is transmitted through spacetime by Timeons in the form of fields to surrounding matter, and this mechanism itself generates gravitational forces between them. We can illustrate this analysis using Figure 4.

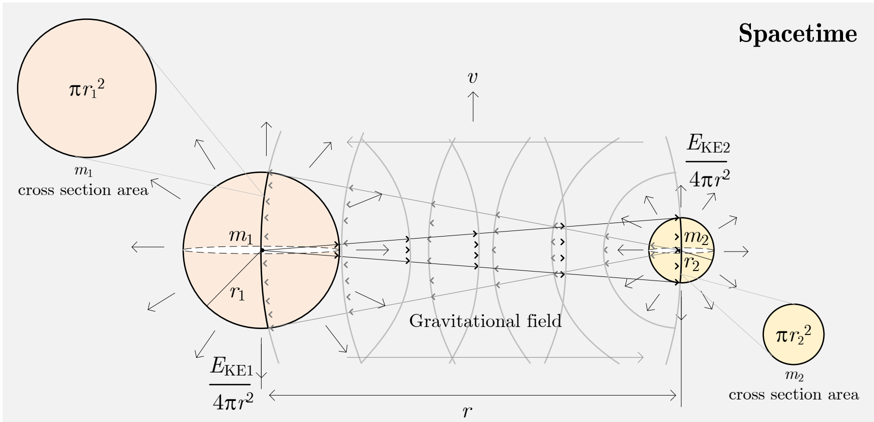


Figure 4. Energy transmission between matter through spacetime

From Figure 4, the matter of mass m_1 and the matter of mass m_2 move with equal velocities v, and the distance between the two matters is r. When considering the energy intensity from mass m_1 transmitted to mass m_2 (E_{21}) and the energy intensity from mass m_2 transmitted to mass m_1 (E_{12}), with the receiving areas of mass m_1 and m_2 being πr_1^2 and πr_2^2 respectively, it can be shown that:

$$E_{21} = -\frac{E_{\mathrm{KE1}}}{4\pi r^2} \cdot \pi r_2^2 \tag{7.1}$$

$$E_{12} = -\frac{E_{\mathrm{KE2}}}{4\pi r^2} \cdot \pi r_1^2 \tag{7.2}$$

when E_{KE1} and E_{KE2} represent the relativistic kinetic energy of masses m_1 and m_2 respectively, and r_1 and r_2 denote the radii of m_1 and m_2 respectively. The negative sign indicates the direction of energy moving away from the center of mass. The energy received by m_1 and m_2 will be converted into forces acting on the masses, as shown by:

$$-\frac{(\gamma-1)m_1c^2}{4\pi r^2} \cdot \frac{\pi r_2^2}{2r_2} + \frac{(\gamma-1)m_2c^2}{4\pi r^2} \cdot \frac{\pi r_1^2}{2r_1} = 0 \tag{8.1}$$

$$-\frac{(\gamma-1)m_1c^2}{8r^2} \cdot r_2 + \frac{(\gamma-1)m_2c^2}{8r^2} \cdot r_1 = 0 \tag{8.2}$$

$$\frac{(\gamma-1)c^2}{8r^2} \cdot (-m_1r_2 + m_2r_1) = 0 \tag{8.3}$$

The equation (8.3) is valid when

$$(-m_1r_2 + m_2r_1) = 0 \tag{9}$$

thus, the mass-to-radius ratio at equilibrium is determined by the equation as follows:

$$\frac{m_2}{r_2} = \frac{m_1}{r_1} \tag{10}$$

The equation (10) illustrates the relationship between the mass-to-radius ratio of two masses, leading to the equilibrium of gravitational forces. Utilizing equations (8.1) and (10), we can show the gravitational force equation as:

$$\left|F_{21}\right|=\left|F_{12}\right|=F_{g}=\frac{(\gamma-1)m_{1}c^{2}}{8\left(r^{2}/r_{1}\right)}.\frac{m_{2}}{m_{1}} \tag{11}$$

Upon examining equation (11), we notice its resemblance to Newton's law of gravitation. We can rearrange it for comparison as follows:

$$F_{g}=\underbrace{\frac{(\gamma-1).c^{2}}{8\left(m_{1}/r_{1}\right)}\cdot\frac{m_{1}}{r^{2}}}_{g_{E}}\cdot m_{2}=G_{r}\cdot\frac{m_{1}m_{2}}{r^{2}} \tag{12}$$

where G_r represents the gravitational relation, which varies with the matter's velocity. It is related to

$$G_{r}=\frac{(\gamma-1).c^{2}}{8\left(m_{1}/r_{1}\right)} \tag{13}$$

In the case where the ratio of m_1 to r_1 equals the ratio of mass to the radius of the Earth, and matter has a velocity comparable to that of the Earth, we can show that $G_r = G$, with G being the universal gravitational constant, equal to $6.674{\cdot}10^{-11}$ ($m^3/Kg.s^2$). From the equation (12), g_E is the new gravitational acceleration of the Earth, which is expressed as:

$$g_{\mathrm{E}}=\frac{(\gamma-1).c^{2}}{8\left(m_{\mathrm{E}}/r_{\mathrm{E}}\right)}\cdot\frac{m_{\mathrm{E}}}{r^{2}}=\frac{(\gamma-1).c^{2}}{8r_{\mathrm{E}}\alpha_{\mathrm{E}}^{2}} \tag{14}$$

where $\alpha_{\mathrm{E}} = r/r_{\mathrm{E}}$ represents the ratio of the distance from the center to the radius of the Earth, and $m_{\mathrm{E}}/r_{\mathrm{E}}$ signifies the mass-to-radius ratio of the Earth. From the aforementioned relationship, we can illustrate it as shown in Figure 5.

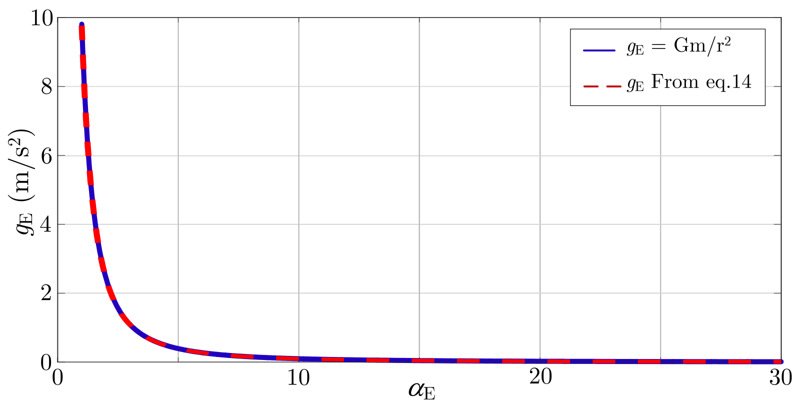


Figure 5. Comparison of gravitational acceleration over distance

Figure 5 depicts the gravitational acceleration as a function of distance, which decreases and varies inversely with the square of the distance from the center of the Earth. The calculated gravitational acceleration values at the Earth's surface from equation (14) are close to the measured average value of approximately 9.81 m/s^2.

3.2 Gravitational Time Dilation by Timeons Accumulation

The greater the gravitational field, the slower time passes for matter, a phenomenon predicted by Einstein's general theory of relativity. According to this theory, time moves more slowly in stronger gravitational fields, a concept known as gravitational time dilation. However, the exact mechanism by which gravitational fields affect time remains an open question. In this section, we will explore this phenomenon from a new perspective, involving the accumulation of Timeons surrounding matter, as shown in Figure 6.

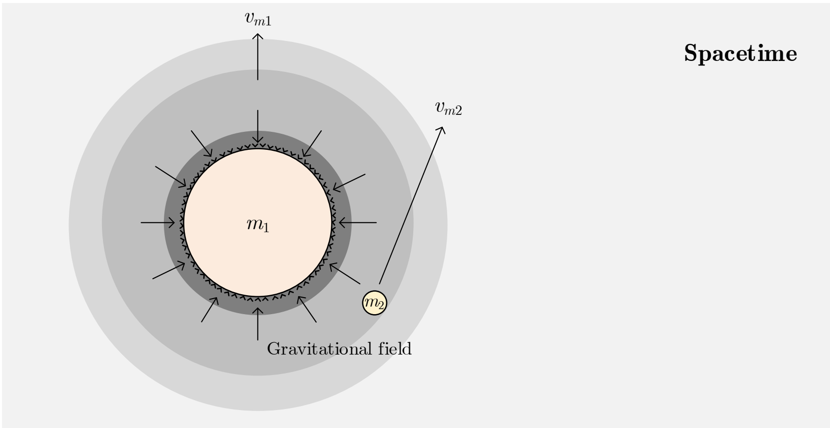


Figure 6. The gravitational fields surrounding matter

In Figure 6, it can be observed that a massive object causes a curvature in spacetime around it, as described by Einstein's general theory of relativity. Simultaneously, hypothetical particles referred to as Timeons accumulate densely around the massive object, representing the strong gravitational field (dark color). In this scenario, the Timeons move more slowly, consistent with the intensity of the gravitational field. When another object with mass m_2 passes through this region, it interacts with the altered spacetime. According to equation (4), the time dilation experienced by m_2 is related to the velocity of the Timeons, leading to a greater time dilation effect and resulting in a slower passage of time for m_2.

4. Conclusions

This article presents the hypothesis of the existence of elementary particles called Timeons. Timeons are hypothesized to be integrated with spacetime, forming a unified entity that reveals a hidden one-dimensional aspect of time within three-dimensional space. This amalgamation results in four-dimensional spacetime. When matter moves through this spacetime, it interacts with Timeons, leading to the emergence of a reference time for the matter. For practical understanding, this reference time is commonly referred to as "time." Analysis of a matter's velocity relative to that of Timeons suggests that time dilates, consistent with the special theory of relativity, supporting the hypothetical presence of Timeons in spacetime. Furthermore, when Timeons move through matter, they are proposed to exert resistance to its motion, aligning with Newton's third law of motion and preventing matter from exceeding the speed of light. Additionally, Timeons are described as energy carriers within spacetime, transferring energy between objects and resulting in gravitational forces that vary inversely with the square of the distance, in accordance with Newton's law of gravity. Based on this hypothesis, Timeons are posited to play a crucial role in the emergence of real-time for matter, which can progress more quickly or slowly depending on relativistic effects. Timeons are also proposed to directly influence the generation of gravitational forces, acting as a fundamental factor in creating gravity, regulating the speed of matter, and providing a quantitative basis for establishing time within the framework of general relativity.

Despite its novelty, the hypothesis remains speculative, lacking direct experimental evidence or established theoretical frameworks to validate the existence of Timeons. We hypothesize, however, that Timeons may be closely related to exotic particles with magnetic properties [Connor et al., 2024] and to the magnetic field lines surrounding black holes [Cooper, 2024]. The mechanisms by which Timeons interact with matter require significant theoretical refinement and experimental validation. While their direct detection may be infeasible, their effects could potentially be observed indirectly—for instance, through their influence on radioactive decay processes.

By introducing the concept of Timeons, this study offers a new perspective on the fundamental links between time, gravity, and spacetime, paving the way for further theoretical and experimental investigations. Future research will aim to develop testable predictions and experimental approaches to examine the potential role of

Timeons in phenomena such as time dilation and gravitational time dilation.

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Authors' contributions

Ittipat Roopkom = IR, Pichet Wisartpong = PW, Wirote Jongchanachavawat = WJ, Beverly F. Stout = BS, Tawatchai Mayteevarunyoo = TM, Paramote Wardkein = PaW — Conceptualization, IR, BS.; Methodology, WJ, IR.; Validation, IR, BS, TM, PaW.; Formal Analysis, IR, PaW.; Investigation, IR, PW, BS.; Resources, IR, BS.; Data Curation, PW.; Original Draft Preparation, IR.; Writing – Review & Editing, IR, BS, PW, TM, PaW.; Visualization, PW.; Supervision, IR.; Project Administration, IR, PW.; Funding Acquisition, IR.

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Data sharing statement

No additional data are available.

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