# Relativity Cosmology

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**Abstract**

This paper presents a simple cosmology that incorporates absolute spacetime and relativity. It assumes the existence of absolute spacetime, where the observer is stationary in the cosmic rest frame and free from the influence of gravity. In this frame, time flows at the fastest rate, and space expands linearly. Moving travelers have a relative universe proportional to their proper time, while the age of the universe remains unified. The Hubble constant, which represents the rate of expansion of the universe, is also redefined. This simple cosmology can provide a new perspective and insights into the universe.

## Introduction

The inconsistency in the measurement of the Hubble parameter has been raised as a significant issue in contemporary cosmology. Solutions have been sought by refining existing theories or sophisticating measurement techniques, but the problem has not been resolved. The increasing Hubble tension over time suggests the need for a new perspective and approach to the universe. This paper briefly introduces a cosmology that considers absolute spacetime and the traveler's proper time. Through a simple thought experiment, it redefines the cosmic spacetime and deduces the Hubble parameter. It explores the cosmological reasons for the variation in proper time and speculates on the potential causes of the accelerated expansion of the universe.

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# Theory

The spaceship is orbiting a planet at a constant velocity close to the speed of light. At that moment, a stellar A, located one light-year away, bursts into a supernova. One year later, the flash from the explosion engulfs the planet.

$$\tau = \frac{T}{\gamma} \tag{1}$$

Where $\tau$ represents the proper time for a moving traveler, $T$ for a stationary observer, and $\gamma$ signifies the Lorentz factor [1]. From the point of a supernova explosion, inhabitants of a planet die approximately a year later. However, for a traveler aboard a spaceship, this duration is less than a year. The events must occur simultaneously, so the travel time of light must be reduced from the perspective of the spaceship. This implies a contraction of space. The distance between the spaceship and stellar A contracts by $1/\gamma$ compared to a stationary observer. The travel time of light is shortened by $1/\gamma$. As a result, the traveler dies relatively quickly.

Consider that, before the arrival of the flash from the explosion, the traveler changes his mind and decides to land on a planet. What happens at the moment the spaceship decelerates? The distance from stellar A increases, resulting in a longer time for the flash to travel. As a result, the traveler can survive a bit longer. The size of space changes according to proper time, and this concept is directly applicable to the universe.

$$R(t) = c\tau \tag{2}$$

Where $R(t)$ is the size of the universe, $c$ is the speed of light traveling in a vacuum from the perspective of absolute rest, and $\tau$ is the traveler's proper time that has elapsed since the beginning of the Big Bang. The value of $R(t)$ reaches its maximum when at rest in the absolute rest frame, especially, time at this point is defined as the age of the universe, denoted as $T$. Consider a situation where an observer at rest in the cosmic rest frame is observing a spaceship accelerating.

$$\frac{R(t+\Delta\tau)}{R(t)} = \frac{\gamma(t)}{\gamma(t+\Delta\tau)}\left(\frac{T+\Delta T}{T}\right) \tag{3}$$

Where $R(t+\Delta\tau)$ represents the changed size of the universe in the traveler's timeframe. Since the time of the stationary observer flows the same as the universe's time, the observer's proper time can be denoted as $T$. From the perspective of a stationary observer, if time $\Delta T$ passes, the same amount of time, $\Delta T$, also elapses in the universe's time. Considering $\tau = T/\gamma$, The equation is then restructured, ensuring that $\Delta\tau \to 0$.

$$\lim_{\Delta\tau\to 0} \frac{R(t+\Delta\tau)-R(t)}{R(t)} = \frac{\Delta T}{T}\frac{\gamma(t)}{\gamma(t+\Delta\tau)} + \frac{\gamma(t)-\gamma(t+\Delta\tau)}{\gamma(t+\Delta\tau)} \tag{4}$$

$$\lim_{\Delta\tau\to 0}\frac{R'(t)}{R(t)} = \frac{\Delta T \Delta\tau^{-1}}{T} - \frac{\gamma'(t)}{\gamma(t)} \tag{5}$$

By Lorentz invariance [2] $d\tau = dT/\gamma(t)$, substitute it and rearrange.

$$\frac{R'(t)}{R(t)} = \frac{\gamma(t)}{T} - \frac{\gamma'(t)}{\gamma(t)} \tag{6}$$

By defining $H(t) = \frac{R'(t)}{R(t)}$ and generalizing it, the following equation is derived.

$$H(t) = \frac{1}{\tau} - \frac{\gamma'}{\gamma} \tag{7}$$

If $\gamma' = 0, \gamma = 1$, then $H(t) = 1/T$, which matches the Hubble parameter $H_0$ as defined in the Hubble-Lemaître law [3]. The expansion rate of the universe varies depending on the traveler's motion. If the traveler accelerates sufficiently, the universe could even contract.

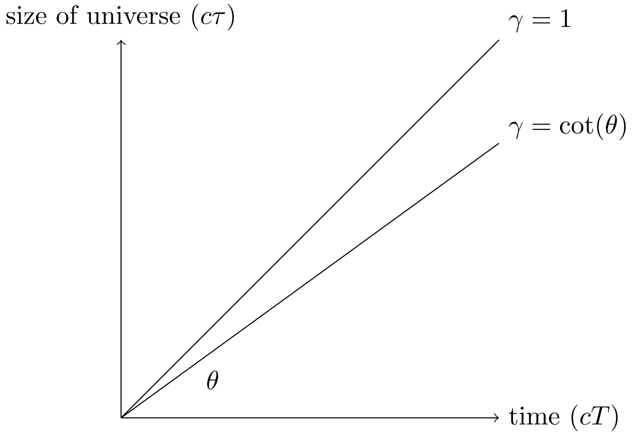

Figure 1: The size of the universe varies according to the proper time of the traveler. The slope of the graph is the reciprocal of $\gamma$, and $\theta$ varies in the range of $0 < \theta < \pi/4$ . The universe is at its maximum size when $\gamma = 1$

In Figure 1, if the value of $\theta$ is constant, the traveler's universe expands at the speed of light at any proper time coordinate. However, the universe is chaotic state where interactions between matter do not cease. The expansion of the universe is not constant and is bound to fluctuate. Multiplying equation (7) by $c\tau$ yields the universe expansion velocity $V(t)$.

$$V(t) = c - c\tau\frac{\gamma'}{\gamma} \tag{8}$$

If $\gamma' < 0$, the expansion speed of the traveler's universe surpasses the speed of light.

# Applying Theory

The CMB (Cosmic Microwave Background Radiation), a powerful evidence of the Big Bang theory, is a microwave background radiation that pervades the entire universe. The CMB originated from an extremely high energy state in the early universe, but is observed in a greatly reduced energy state due to redshift. In other words, it can be simply defined as light that has traveled the universe for a traveler's proper time $\tau$ since the beginning. Therefore, by applying the Hubble-Lemaitre law, it can be expressed in the following relationship.

$$\tau = \frac{1}{H_{cmb}} \tag{9}$$

If calculated with $H_{cmb} = 67\ km/s/Mpc$, it concludes that approximately 14.587 billion years have passed in terms of the proper time. This greatly exceeds the widely accepted age of the universe, 13.8 billion years. And by Equation 7, the following holds true. (However, when measured in the same spacetime frame.)

$$H_{cmb} - H(t) = \frac{\gamma'}{\gamma} \tag{10}$$

By substituting the above results into Equation 8 and rearranging, expansion speed of universe $V(t)$, can be simply derived.

$$V(t) = c\frac{H(t)}{H_{cmb}} \tag{11}$$

If calculated with $H(t) = 73\ km/s/Mpc$, the expansion speed of universe, $V(t) \approx 1.0895c$, which exceeds speed of light by about 9%. This aligns with the principle that objects beyond the Hubble length $c/H(t)$ exceed the speed of light. The last-scattering surface(LSS) is the location from which the cosmic microwave background radiation originates. [4] It delineates the edge of the observable Universe. In other words, the limiting point of the information observable is defined as the cosmological horizon, and in Figure 1, this distance aligns with the size of the universe. Therefore, the distance to the last-scattering surface can be defined as $c\tau$, and the expansion limit size is $cT$.

$$cT = c\tau + c\gamma\Delta t_{lss} \tag{12}$$

Where $\gamma\Delta t_{lss}$ is the completion time of the last-scattering calculated in current time value. By summarizing, the following equation can be derived.

$$\gamma = \frac{1}{1 - H_{cmb}\Delta t_{lss}} \tag{13}$$

If calculated with $\Delta t_{lss} = 380000$ years, the current time delay on Earth $\gamma \approx 1.000026$ is derived. Interestingly, this is similar to the Lorentz factor $\frac{1}{\sqrt{1-\alpha^2}}$ calculated with the speed of ground state electron orbiting hydrogen atom. ($\alpha$ = fine structure constant). Physical constants may vary depending on $\gamma$. In conclusion, the age of the universe $T$ is as follows.

$$T = \frac{1}{H_{cmb}\left(1 - H_{cmb}\Delta t_{lss}\right)} \approx 14.5873Gyr \tag{14}$$

# Hypothesis

While there are various factors that influence proper time, such as observation methods or observation environments (artificial acceleration), among these, astronomical reasons are presumed to be the main cause. The Sun loses approximately 5.5 million tonnes of mass per second due to solar wind and nuclear fusion [5]. This mass loss from the Sun not only reduces the gravitational time delay effect, but also expands its orbit, thereby decreasing its orbital velocity [6]. The Milky Way harbors over a hundred billion stars, and its mass is estimated to be over 200 billion times that of the Sun [7]. While the gravitational time-delay effect diminishes with increasing distance, the sheer mass of the Milky Way makes it impossible to ignore its impact. During the main-sequence phase, stellar mass loss is relatively uniform. However, as a stellar object undergoes evolution, significant changes occur. The rate of fusion increases, causing it to become brighter, and stellar mass loss intensifies [8]. In its final stage, this stellar object either forms a planetary nebula or undergoes massive mass loss through a supernova explosion. Various factors such as the activities of celestial bodies or changes in orbital motion can influence the measurement of the Hubble parameter.

According to research findings, it has been reported that the Milky Way and the Sagittarius dwarf galaxy collided three times over the span of approximately the past 6 billion years. [9]. These collisions disrupted the internal balance of the Milky Way, causing changes in the density of gas and dust and triggering the explosive birth of stars. A hypothesis has been proposed that even our solar system was formed as a result of these events. Interestingly, this period is similar to the time when the accelerated expansion of the universe began. While it remains merely a hypothesis, it is conjectured that if the time-delay effect of the material that once constituted the primitive solar system diminished due to the impact of those collisions, it could potentially explain the accelerated expansion of the universe.

Physical constants probably vary depending on the value of $\gamma$. $\gamma$ itself naturally fluctuates due to celestial variations, which suggests that other physical constants may also undergo minor changes. The possibility of changes in physical constants has been consistently discussed, and the discrepancy in physical constants due to changes in space-time on a cosmic scale is actively being researched in astronomy. [10–12]. This discrepancy might be attributed to variations in $\gamma$. Variations in physical constants such as the Gravitational constant, Planck constant, etc. may provide insights into solving unsolved mysteries in physics. It is of value to confirm this through precise experiments.

# Conclusion

This paper is based on three assumptions. 1) The universe is relative to the traveler's proper time. 2) The size of the universe is defined as the distance that light has traversed in a vacuum over the proper time $\tau$ since the beginning. 3) The concept of the cosmic rest frame is introduced. From the perspective of the cosmic rest frame, travelers possess their own relative universe. If the premise is correct, the rate of expansion of the universe can be expressed by the following equation.

$$H_{cmb} - H(t) = \frac{\gamma'}{\gamma} \tag{15}$$

The Hubble tension problem is speculated to be due to variations in $\gamma$. The discrepancies and variability in data are natural occurrences when considering the capricious nature of celestial bodies in the universe. In the absence of special circumstances, the observed cosmic space within the solar system is expected to continue expanding, but the rate of expansion will decrease over time. The accelerated expansion is conjectured to be caused by the explosive emergence of stars resulting from the collision between the Milky Way and the Sagittarius dwarf galaxy, the birth of the solar system, and the subsequent reduction in the time-delay effect of primitive solar system materials. This is a transient event on a cosmological scale, and over an extended period of time, the expansion speed of the universe will eventually converge to the speed of light, and the expansion rate will converge to zero.

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