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Introducing a 2nd Universal Space-Time Constant Can Explain the Observed Age of the Universe and Dark Energy

Herman A. van Hoeve

Hulst, Netherlands
Email: havanhoeve@gmail.com

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Abstract

The purpose of this paper is to introduce new theoretical concepts as opposed to accepting the existence of dark entities, such as dark energy. This research sought to introduce a 2nd universal space-time constant, besides having a finite speed constant (*speed of light in vacuum c*). A finite universal age constant *b* is introduced. Namely, this paper shows that the changes in the Earth's anomalistic year duration over time support the hypothesis of the age of the universe correlating with a maximum number of orbital revolutions constant. Neglecting the gravitational influence of other cosmological entities in the proximity of the Earth, the constant maximum number of revolutions is herewith determined solely by the Earth's orbital revolutions around the Sun. The value of the universal age constant *b* is calculated to be around 13.8 billion orbital revolutions, derived out of an equation related to the changes in the Earth's anomalistic year duration over time and the so-called Hubble tension. The above-mentioned calculated value *b* correlates well with the best fit to measured data of the cosmic microwave background radiation (CMBR) by the Planck spacecraft, the age of the observed universe is measured to be approximately 13.787 ± 0.020 billion years (2018 final data release). Developing a theory with this 2nd universal space-time constant *b*, being covariant with respect to the Lorentz transformations when time spans are large, gives results such as: A confirmation of the measured CMBR value of 13.787 ± 0.020 billion years. Correlating well with the observed expansion rate of the universe (dark energy). The universe's expansion accelerating over the last four to five billion years.

Keywords

Anomalistic Year, Orbital Revolution, Hubble Tension, Age of the Universe, Cosmological Constant, Dark Energy, Cosmic Microwave Background

1. Introduction

The research aims to introduce new theoretical concepts, so that the introduction of dark entities, such as dark energy, are no longer required. In this research, besides the speed of light being a universal constant, a 2nd universal space-time constant is introduced, additionally being covariant with respect to the Lorentz transformations.

The current problems with needing to introduce dark entities into physics are avoided when extending Einstein's postulates. For example, it explains dark energy (Hubble constant), the relative rate of the expansion of the universe.

Einstein's Special Theory of Relativity Postulates (= *traveling at constant speeds excluding gravity*) are extended as follows:

Postulate 1 of Special Relativity:

The laws of physics take the same form in all inertial frames of reference.

- The laws of physics must thus be the same for any two objects no matter how fast they are moving relative to one another. Speeds are relative and one cannot detect the difference between moving at constant speed and standing still. Any observer may claim to be standing still [1].

Extending Postulate 1:

- The laws of physics must also be the same for any two events no matter how much time lapses between them. Time spans are relative, absolute time does not exist. Any observer may claim to measure the correct time span.

Postulate 2 of Special Relativity:

The speed of light in free space has the same value c in all inertial frames of reference.

- The speed of light (c) is constant. One can never obtain a speed larger than c. All other speeds are subject to this constraint, as no object can move faster than c relative to any other object [1].

Extending Postulate 2:

- The age of the universe is a constant maximum number of orbital revolutions (b). No time span can ever be larger than b. All other time spans are subject to this constraint, as no time span can be larger than b relative to any other event.

The value of *c*: Speed of light in vacuum is around 0.3 gigameters per second.

The value of *b*: The age of the universe is around 13.8 billion years [2].

2. The Age of the Universe

2.1. Changes in the Anomalistic Year Duration over Time

Changes in the anomalistic year duration over time correspond well with having a constant number of orbital revolutions b_{Earth}, as defined by:

$$Y - 2011 = \frac{b_{Earth}}{10^{-9}} * \frac{\Delta P_{calc}}{365.25 * 24 * 3600} \tag{1}$$

Y = the calendar year numbering [-]

b_{Earth} = local anomalistic year constant, $b_{Earth} \approx 12.623$ [billion orbital revolutions]

ΔP_{calc} = calculated delta of the orbital period compared with the epoch J2011.0 [sec] [3]

Table 1 shows that the difference over time of an anomalistic year duration, as recorded in literature [4] [5] [6] [7], and by means of calculating the difference with (1) when b_{Earth} is set at 12.623 [billion orbital revolutions], is small. The value of b_{Earth} is thus tuned in such a way that ΔP_{calc} synchronizes with $\Delta P_{literature}$, *i.e.* the value as recorded in literature. Going forward in time, the anomalistic year duration increases by one second every 400 years.

With the b_{Earth} value set at 12.623, **Table 1** shows that ΔP_{calc} over a time span of 10,000 years correlates with $\Delta P_{literature}$, thus supporting the hypothesis of having a constant number of orbital revolutions (b_{Earth}). This paper extrapolates this hypothesis beyond these 10,000 years, making the value of b_{Earth} a constant over time. In analogy with a constant speed of light (c), all observers on Earth, irrespective when in time, measure the universe's age to correlate with a constant number of anomalistic revolutions (b_{Earth}).

2.2. Hubble Tension Ratio Introduced to Calculate the Observed Age of the Universe

The age of the universe (t_0) is close to the value of Hubble time, the inverse of the Hubble constant (H_0). The Hubble time is the age the universe would have had if the expansion of space had been linear. However, the expansion is not linear, as observations show that Einstein's Cosmological Constant (Λ) has a minute positive value, curving the universe just slightly [8] [9]. This curvature is so small that the effect is detectable only with large cosmological time spans,

Table 1. Comparing Earth's anomalistic year duration with the calculated orbital period.

Year	Anomalistic year fluctuation [4] [5] [6] [7] (https://en.wikipedia.org/wiki/Year)		Calculated orbital period fluctuation by (1)
Y	$P_{J2011.0}$ [3] in sec	$\Delta P_{literature}$ in sec	ΔP_{calc} in sec
4000 BC		−15	−15.03
2000 BC		−11	−10.03
0		−5	−5.03
2000 AD	31 558 432.6 ± 0.1	0	−0.03
4000 AD		+5	+4.97
6000 AD		+10	+9.97

Note: $\Delta P_{literature}$ is in reference to the epoch J2000.0 [sec] [4] [5] [6] [7].

such as say 10 billion years. The observed age of the universe (t_0) is around 13.8 billion years, indeed leading to minute observed curvatures.

Multiple methods have been used to determine the Hubble time (t_H). Estimates based on so-called "late universe" data (distance ladder measurements) cluster at around 13.3 ± 0.3 billion years [10] [11]. Estimates based on so-called "early universe" data (cosmic microwave background variations) cluster at around 14.5 ± 0.2 billion years [10] [11]. The estimated measurement uncertainties have shrunk but the range of measured values has not, to the point that the disagreement between the "late and early universe" data is statistically significant. This discrepancy is called the Hubble tension [11].

The mismatch between the locally measured expansion rate of the universe and the one inferred from the cosmic microwave background measurements is herewith defined as a ratio, introducing a factor that accounts for this statistically significant difference.

$$r_{ht} = \frac{14.5 \pm 0.2}{13.3 \pm 0.3} \Rightarrow r_{ht} = 1.09 \pm 0.04 \tag{2}$$

r_{ht} = Hubble tension as ratio, $r_{ht} \approx 1.09$ [ratio cosmic horizon versus local measurements]

To account for the observed difference between the "early universe" and "late universe" values of the Hubble time, r_{ht} is introduced as a correction factor, so to calculate the value of the cosmic horizon constant b_{CMBR} out of the locally derived constant b_{Earth}:

$$b_{CMBR} = r_{ht} * b_{Earth} \Rightarrow b_{CMBR} = 13.8 \pm 0.5 \tag{3}$$

b_{CMBR} = cosmic horizon constant, $b_{CMBR} \approx 13.8$ [billion orbital revolutions]

b_{Earth} = local anomalistic year constant, $b_{Earth} \approx 12.623$ [billion orbital revolutions]

r_{ht} = Hubble tension as ratio, $r_{ht} \approx 1.09$ [ratio cosmic horizon versus local measurements]

Based on the best fit to Planck spacecraft measured data, the age of the universe is measured to be approximately 13.787 ± 0.020 billion years (2018 final data release) [2]. This paper shows that the value of the observed age of the universe derives out of (3).

Note that the cosmological principle, which states that on a large-enough scale the universe remains isotropic as well as homogeneous, does not fail with r_{ht} not being equal to one. Namely, new theoretical concepts are introduced for large cosmological distances and time spans, as discussed in chapter 3.

3. The Special Theory of Double Relativity

3.1. Einstein's Special Theory of Relativity

The laws of physics are covariant with respect to the Lorentz transformations. All observers measure the same value c, even when relative speeds become large [1].

$$V = \frac{V_x + V_y}{1 + \left(\frac{V_x * V_y}{c^2} \right)} \tag{4}$$

with $|V_x| \le c \quad V_x > 0$ when x is moving away from the observer
with $|V_y| \le c \quad V_y > 0$ when y is moving away from the observer

Note that the space direction of V_x being the opposite of V_y.

V = relative speed between x and y [m/s]

V_x = relative speed between x and the observer [m/s]

V_y = relative speed between y and the observer [m/s]

c = speed of light in vacuum constant [m/s]

3.2. Extending Einstein's Special Relativity Theory with a 2nd Universal Constant

Lorentz transformations are also necessary when extending the laws of physics with a second universal constant, the maximum number of orbital revolutions constant b [12]. All observers measure the same value b, even when relative time spans become large.

$$T = \frac{T_x + T_y}{1 + \left(\frac{T_x * T_y}{b^2} \right)} \tag{5}$$

with $|T_x| \le b \quad T_x > 0$ when x is in the future of the observer
with $|T_y| \le b \quad T_y > 0$ when y is in the past of the observer

Note that the time direction of T_x being opposite of T_y.

T = relative time span between x and y [billion orbital revolutions]

T_x = relative time span between x and the observer [billion orbital revolutions]

T_y = relative time span between y and the observer [billion orbital revolutions]

b = maximum number of orbital revolutions constant [billion orbital revolutions]

3.3. The Value of the Hubble Constant

This paper shows that the value of the Hubble constant (H_0), interpreted here as the relative rate of the expansion of the universe, derives out of (5).

Note that Einstein's Cosmological Constant (Λ) has a very small positive value, curving the universe just slightly; when compared to the observed 13.8 billion years old age of the universe, this leads to minute observed curvatures. At the current observed relative rate of the expansion of the universe, it takes approximately one billion years for an unbound structure to grow by approximately 7% [8] [9].

The relative time span between one billion years in the future and the observed cosmic microwave background radiation (CMBR) can be calculated by means of (5):

$$T = \frac{T_x + T_y}{1 + \left(\frac{T_x * T_y}{b^2} \right)} \approx \frac{1 + 13.8}{1 + \left(\frac{1 * 13.8}{13.8^2} \right)} \approx \frac{14.8}{1.072} \approx 13.8$$

T = relative time span between T_x and T_y [billion orbital revolutions]

T_x = one billion years in the future of the observer [1 billion orbital revolutions]

T_y = CMBR is in the past of the observer [13.8 billion orbital revolutions]

b = maximum number of orbital revolutions constant [13.8 billion orbital revolutions]

Thus, the relative time span between 1 billion orbital revolutions in the future and the observed CMBR is not 14.8, it remains at 13.8 billion orbital revolutions. The subsequent correction factor of 1.072 correlates with the observed relative rate of the expansion of the universe, taking one billion years for an unbound structure to grow by approximately 7%. So-called dark energy is nothing more than this correction factor, as shown above.

Note that distant galaxies do not disappear in the future beyond the horizon of the universe. For example, the relative time span between one billion years in the future and the observed galaxy HD1, which is approximately 13.5 billion years old [13], can be calculated by means of (5).

$$T = \frac{T_x + T_y}{1 + \left(\frac{T_x * T_y}{b^2}\right)} \approx \frac{1 + 13.5}{1 + \left(\frac{1 * 13.5}{13.8^2}\right)} \approx \frac{14.5}{1.071} \approx 13.5$$

T = relative time span between T_x and T_y [billion orbital revolutions]

T_x = one billion years in the future of the observer [1 billion orbital revolutions]

T_y = galaxy HD1 is in the past of the observer [13.5 billion orbital revolutions]

b = maximum number of orbital revolutions constant [13.8 billion orbital revolutions]

3.4. Describing Relative Time Spans with Both Events in the Past

The relative time span between two events in the past is discussed in this paragraph.

Equation (5) calculates the relative time span between one event in the future of the observer and one in the past. The following equations deal with both events in the past.

$$t_x = -\frac{T_x}{b} \quad (6)$$

with $|T_x| \le b$ $\quad T_x > 0$ when x is in the future of the observer

$t_x > 0$ when x is in the past of the observer

T_x = relative time span between x and the observer [billion orbital revolutions]

t_x = relative time span between x and the observer [-]

b = maximum number of orbital revolutions constant [billion orbital revolutions]

$$t_y = \frac{T_y}{b} \quad (7)$$

with $\left|T_y\right| \le b \quad T_y > 0$ when y is in the past of the observer

$t_y > 0$ when y is in the past of the observer

T_y = relative time span between y and the observer [billion orbital revolutions]

t_y = relative time span between y and the observer [-]

b = maximum number of orbital revolutions constant [billion orbital revolutions]

$$t = \frac{T}{b} \tag{8}$$

with $\left|T\right| \le b$

T = relative time span between x and y [billion orbital revolutions]

t = relative time span between x and y [-]

b = maximum number of orbital revolutions constant [billion orbital revolutions]

By combining (5)-(8), one can define t as:

$$t = \frac{t_y - t_x}{1 - \left(t_y * t_x\right)} \tag{9}$$

with $\left|t_x\right| \le 1 \quad t_x > 0$ when x is in the past of the observer

with $\left|t_y\right| \le 1 \quad t_y > 0$ when y is in the past of the observer

t = relative time span between x and y [-]

t_x = relative time span between x and the observer [-]

t_y = relative time span between y and the observer [-]

3.5. The Relative Time Span Ratio Equation

The relative time span ratio equation is introduced in this paragraph, see also Figure 1.

$$r = \frac{t}{t_y - t_x} \tag{10}$$

Combining (9) and (10), see also Figure 1:

$$r = \frac{1}{1 - \left(t_y * t_x\right)}\text{; with } t_x \ne t_y \tag{11}$$

r = ratio between the values of t and $(t_y - t_x)$ [-]

t = relative time span between x and y [-]

t_x = relative time span between x and the observer [-]

t_y = relative time span between y and the observer [-]

3.6. The Relative Time Span Delta Equation

The relative time span delta equation is introduced in this paragraph, see also Figure 2.

$$\delta = \left(t_y - t_x\right) - t \tag{12}$$

Combining (9) and (12), see also Figure 2:

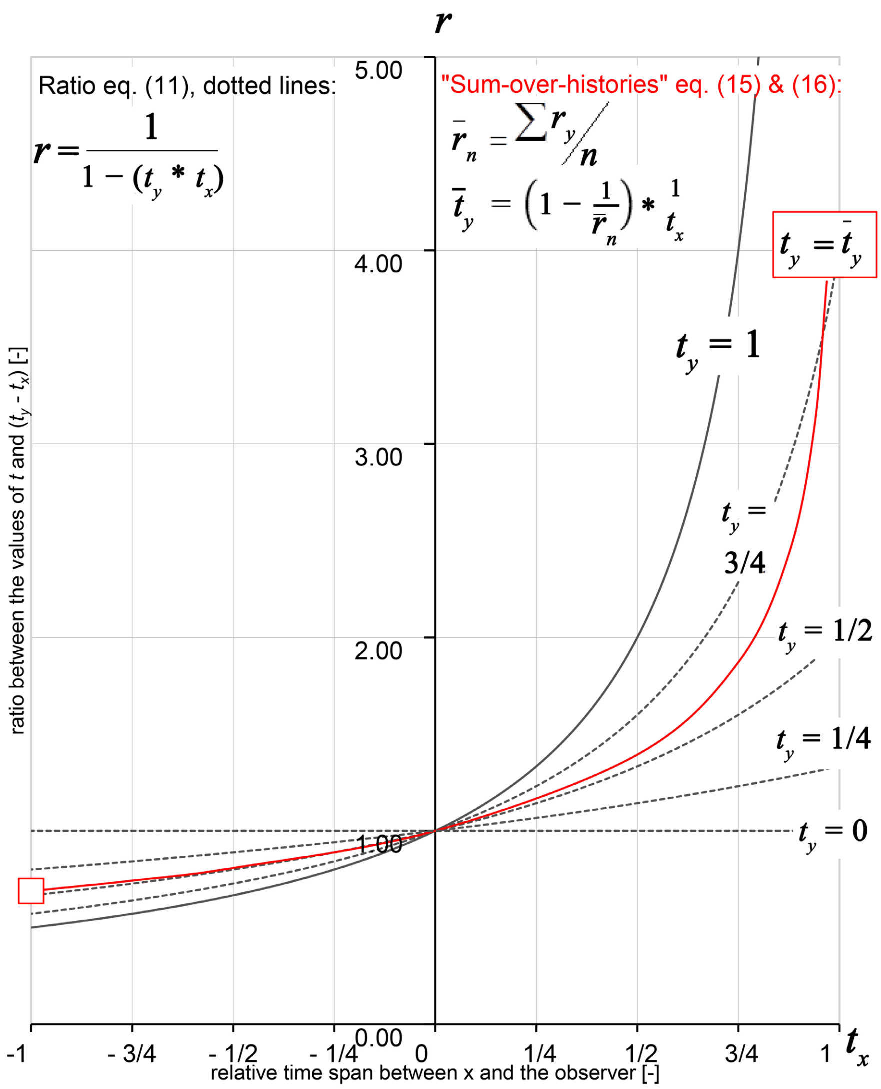

Figure 1. The relative time span ratio equation.

$$\delta = \frac{t_y - t_x}{1 - \left(\frac{1}{t_y * t_x}\right)} \tag{13}$$

δ = delta between the values of ($t_y - t_x$) and t [-]

t = relative time span between x and y [-]

t_x = relative time span between x and the observer [-]

t_y = relative time span between y and the observer [-]

Combining (11) and (13):

$$\delta = (1 - r) * \left[\left(\left(1 - \frac{1}{r}\right) * \frac{1}{t_x}\right) - t_x\right] \tag{14}$$

δ = delta between the values of ($t_y - t_x$) and t [-]

r = ratio between the values of t and ($t_y - t_x$) [-]

t_x = relative time span between x and the observer [-]

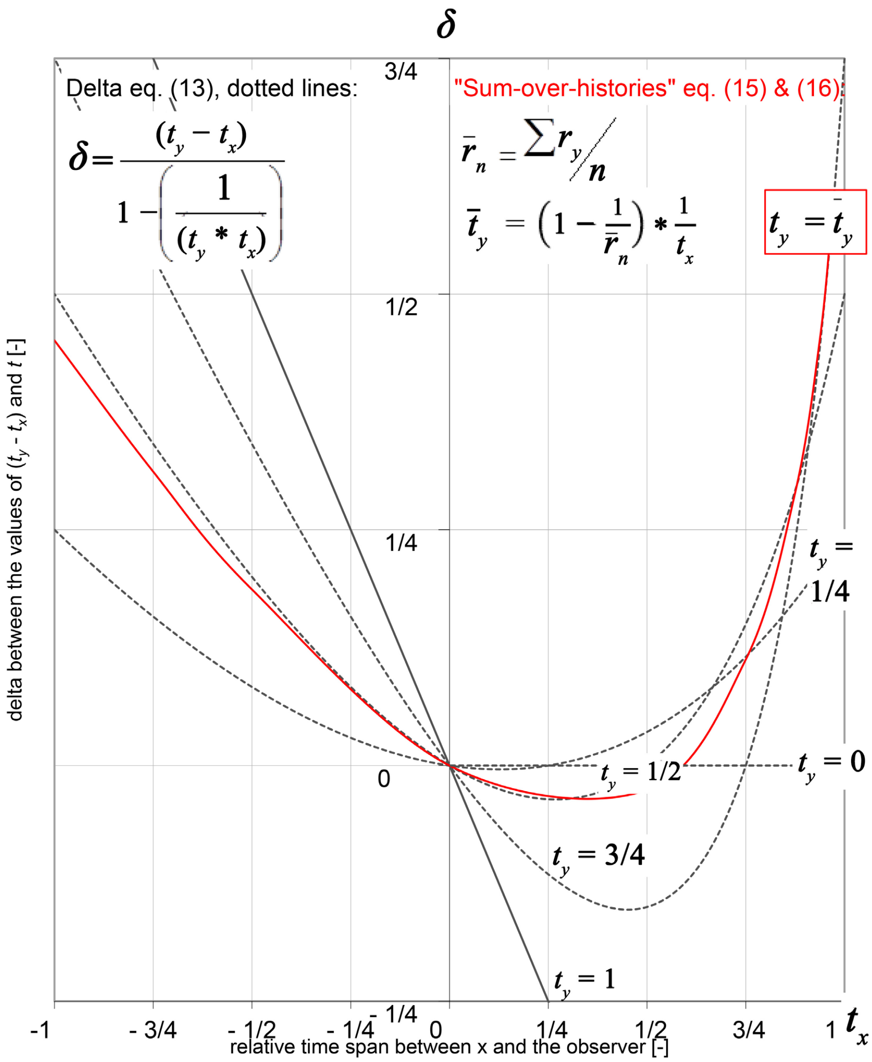

Figure 2. The relative time span delta equation.

3.7. The "Sum-Over-Histories" Relative Time Span Ratio Equation

The concept of a "sum-over-histories" relative time span is herewith introduced, e.g. to determine when the expansion of the universe became ever faster. By means of (11), one can average out the ratio values ($0 < t_y \le 1$) into a "sum-over-histories" ratio $\overline{r}_n$ for any specific value of t_x. Figure 1 visualizes an example in which ratio values are averaged out for $t_y = 1, 63/64, 62/64, 61/64, \ldots 2/64, 1/64$.

$$\overline{r}_n = \frac{\sum r_y}{n}\text{; with } y > 0 \quad (15)$$

$\left(\overline{r}_n\right)_{x \to 1} \to \infty$ is related to the idea of a period of universal inflation after the Big Bang.

$\overline{r}_n$ = "sum-over-histories" ratio; the averaged-out value over integer-n r_y-values [-]

r_y = ratio for value t_y; this at a specific value of t_x [-]

n = integer number of r_y-values that are averaged out [-]

y, x = short descriptions for the relative time spans t_y and t_x respectively [-]

By means of (11), one can define the "sum-over-histories" value $\overline{t_y}$, see Figure 1 and Figure 2:

$$\overline{t_y} = \left(1 - \frac{1}{\overline{r_n}}\right) * \frac{1}{t_x} \tag{16}$$

$\overline{t_y}$ = "sum-over-histories" t_y-value; this for a certain value of t_x [-]

$\overline{r_n}$ = "sum-over-histories" ratio; the averaged-out value over integer-n r_y-values [-]

t_x = relative time span between x and the observer [-]

The concept behind the ratio $\overline{r_n}$ is to use an averaged-out value for r_y to calculate a "sum-over-histories" $\overline{t_y}$ value for all the possible t_y values at a certain value of t_x.

By means of (13), one can define $\overline{\delta}$, the delta between the values of ($\overline{t_y} - t_x$) and t.

Figure 2 shows $\overline{\delta}$ changing from decreasing to increasing at $t_x \approx 0.33$.

$$\left(\frac{d\left(\overline{\delta}\right)}{d\left(t_x\right)}\right)_{t_x \approx 0.33} = 0$$

$\overline{\delta}$ = delta between the values of ($\overline{t_y} - t_x$) and t [-]

t_x = relative time span between x and the observer [-]

Thus, the line $t_y = \overline{t_y}$ reaches its lowest point in Figure 2 at $t_x \approx 0.33$. This explains why the observed expansion of the universe has been accelerating over the last 4 to 5 billion years [8] [9]. The dominance of so-called dark energy during these 4 to 5 billion years derives out of the curvature of the line $t_y = \overline{t_y}$ in Figure 2. Note that the maximum number of orbital revolutions constant is defined as b (chapter 2), e.g. the cosmic horizon constant being 13.8 billion orbital revolutions.

4. Explaining Cosmological Observations

Chapter 3 has already discussed the observed age of the universe, the value of the Hubble constant (so-called dark energy), and the moment when the expansion of the universe became ever faster.

This chapter explains some other cosmological observations from Earth.

- The universe's cosmic microwave background is smooth [14].
- Non symmetric boundaries condition at the horizon of the universe [15].

4.1. The Universe's Cosmic Microwave Background Is Smooth

The universe cosmic microwave background radiation has been observed to be smooth [14], even when comparing areas of the universe that should not have been in contact.

However, having 2 constants (c & b) explains that the whole universe is "in contact" [12]. Namely, the extension of postulate 2 states that the relative time span between two events can never be further apart than the maximum number of orbital revolutions constant *b*.

Note that introducing the 2nd universal constant *b* also means that the laws of physics do not break down at the maximum time span in the past, the so-called Big Bang. Namely, the value of *b* is a maximum constant, a new theoretical concept embedded in physics.

4.2. Non Symmetric Boundaries Condition at the Horizon of the Universe

One would expect that at the largest scales of the observable universe symmetry should prevail, any one direction should be similar. However, experimental observations of fluctuations in the cosmic microwave background show that the random motion (= heat) in these large-scale modes is not symmetric; there is a preferred direction [15]. The WMAP images show evidence of a non-symmetric boundaries condition, the red tilt in the amplitudes of energy density fluctuations in the cosmic microwave background radiation temperature. This red tilt is a deviation from perfect scale-variance, having slightly smaller amplitude as the wave-length decreases.

Having two constants (*c* and *b*) explains that the observable universe is "closed", with a geometry that is tilted towards the direction of the observer [12].

Note that as the Theory of Relativity is inherently background independent, one also could describe the observed acceleration of the expansion of the universe as being a relative ever faster shrinking of geometric observations compared to the static boundaries of the universe. The Theory of Relativity allows this without jeopardizing any physical law. Thus, the above-mentioned tilting, in the direction towards the observer, may indeed explain this non-symmetric aspect.

Conflicts of Interest

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

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Appendix

Appendix 1. Outer Galaxies Are Rotating too Fast around Their Galaxy Cluster Center

The following is speculative; more insight and further theoretical studies are required.

According to classic Newtonian physics, the orbital speed of the outer galaxies around the center of a galaxy cluster should be proportional to the reciprocal value of the square root of its distance to the center. However, outer galaxies are observed to rotate too fast around the galaxy cluster center [16]. Similar observations are made of distant outer stars rotating too fast around the center of its galaxy [16].

Although the Earth's anomalistic orbital period changes over time, the Conservation Law regarding time symmetry remains respected, defined as a constant maximum number of orbital revolutions b (see chapter 2). A puzzling aspect of having this constant b is the fact that the location of the observer influences the cosmic microwave background radiation and/or Hubble tension measurements, thus seemingly not respecting the Conservation Law regarding space symmetry. One can speculate that the spin of the observer's location within the universe adjusts observed measurements in such a way that b remains constant.

Outer galaxies spin around their galaxy cluster center. Outer stars spin around their galaxy center. By neglecting the gravitational influence of other cosmological entities in the proximity of observed outer spinning objects, the constant maximum number of revolutions b is hereby determined solely by the orbital revolutions around their center. Observing the universe from Earth, all the outer spinning objects must thus have a similar number of rotations around their center, which is observed from Earth to be similar orbital periods around their center. They thus align to the location of the observer: Earth's spin around the Sun. If one would observe the Universe from the outer spinning objects themselves, cosmological observations would abide by classic Newtonian physics.

One can draw an analogy between the phenomena of light bending around large cosmological objects (*re*: *Einstein's General Theory of Relativity*) and above-mentioned phenomena of the discrepancy between the observed & actual relative orbiting periods.

Equation (9) can be modified into (17) when the distances from the observer to both objects are cosmologically large, compared with the observed relatively short distance between the two objects. The Δt value is relatively small compared with t_x and t_y.

$$t_\Delta \approx \frac{\Delta t}{1-t_x^2}\text{; With } \Delta t = t_y - t_x,\ t_y \approx t_x,\ \Delta t \ll t_x \tag{17}$$

t_Δ = relative time span between the observed object y & x, both objects far away [-]

Δt = relative observed time span between y and x, by the observer [-]

t_y = relative time span between the observed y and the observer [-]

t_x = relative time span between the observed x and the observer [-]

Equation (17) is a simplistic view of the physics involved.

Appendix 2. Galaxies Are Rotating too Fast and the Influence of a Black Hole

The following is speculative; more insight and further theoretical studies are required.

According to currently known physics, galaxies are rotating too fast, the cause of which is assumed also to be the influence of a black hole [17].

The relative time span between the black hole's horizon and the cosmic microwave background radiation may be minute in the direction towards the black hole center location, thus making the geometric shape of a black hole two dimensional (holographic). The black hole's horizon is thus described as being located close to the Universe horizon itself. Metaphorically speaking, a black hole becomes an umbilical cord of sorts for its surrounding space. One can speculate if the idea of an umbilical cord explains why each galaxy appears to have a black hole at its center.

Equation (9) can be modified into (18) when the time span between the black hole's horizon and the cosmic microwave background radiation is anticipated to be close to zero, thus the value of $t_y \approx 1$:

$$t_b \approx \frac{1-t_x}{1-(1*t_x)} \Rightarrow t_b \approx 1 \tag{18}$$

t_b = relative time span between object x nearby the black hole and the black hole y [-]

t_y = relative time span between the black hole y and the observer, $t_y \approx 1$ [-]

t_x = relative time span between object x nearby the black hole and the observer [-]

Equation (18) is a simplistic view of the physics involved.

The observer measures the time span between the perceived black hole location and object x, adjacent to the black hole, to be much smaller than t_b. Observing the Universe from Earth, the orbital period of the object x appears to be rotating too fast. Note that if one would observe the Universe from the location of object x itself, cosmological observations would abide by already known physics.

The black hole horizon is suggested to function as a one directional "closing-in on the Universe", as compared to the opposite direction towards the observer. So, having a much closer positioning to the Universe horizon in one specific direction, tilting away from so-called "symmetric location". The link between a black hole's horizon and the Universe horizon may also explain why the entropy of a black hole appears to be a function of area instead of volume [18]; volume means little to a black hole.