ISSN: 2978-0632

Review Article

Open Access Journal of Physics and Science

Decreasing Universe Theory: Cosmological Time Dilation and the SN1A Explosion

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Received: June 04, 2026; **Accepted:** June 09, 2026; **Published:** June 16, 2026

Abstract
We will show that, within the "Decreasing Universe Theory" (DUT), time inside a gravitational field is altered in the same way as spatial distance measurement scales. At the cosmic level (timescales of millions of years), this effect becomes perceptible and explains the variation in the measured duration of Type Ia Supernova (SN1A) explosions.

Keywords: Decreasing Universe Theory, DUT, Dark Energy, Dark Matter, Space expansion, Universe, Light speed, c, SN1A, Supernova, Time Dilation

Introduction

The central hypothesis of DUT is that the gravitational field produces the contraction of space and everything contained within that space. It also establishes that this contraction is faster the stronger the gravitational field is. The contraction is extremely slow: on Earth we estimate a contraction rate of about 7% for every 1 billion years [1,2].

Outside the galaxy, in sidereal space, gravitational fields are very weak and may be considered negligible. Thus, an observer in that region ("SO"), outside the gravitational field, is not shrunk and may therefore be considered a privileged observer, analogous to an "inertial observer" in Newtonian mechanics.

We shall call this sidereal observer a "comoving observer". In this way, the laws of physics for a comoving observer do not need to be re-adjusted to compensate for the contraction of their measuring instruments by gravitational contraction. This contraction happens to an observer subjected to a gravitational field, for example inside a galaxy, and we shall call such an observer a proper observer.

Dark Energy

In DUT, as already seen in, the contraction produced by the gravitational field causes our measuring instruments (rulers, scales, etc.) to become continuously smaller, that is, continuously contracted.

As a consequence, we measure galaxies at increasingly larger distances, giving us the APPARENT EFFECT that they are moving away from us (as a result of the contraction of our rulers and distance standards).

The more distant the galaxies are, the longer the photon emitted by them takes to arrive here and, consequently, the longer we keep shrinking and therefore the larger the wavelength measured upon arrival becomes (larger redshift).

From this comes the apparent accelerated recession of galaxies and the hypothesis of "Dark Energy" introduced to explain this apparent acceleration.

In this way, we may list 3 factors that contribute to galaxy redshift

1. **Mass:** The greater the mass of the galaxy that emits the photon, the greater its contraction rate. Therefore, for galaxies at the same distance and with the same age, the more massive ones should present a SMALLER redshift than the less massive ones.
2. **Age:** For galaxies with the same mass and at the same distance from Earth, the older galaxies should present a SMALLER redshift than the younger ones. This occurs because the atoms of older galaxies have remained under gravitational contraction for a longer time than those of

Citation: João Carlos Holland de Barcellos. Decreasing Universe Theory: Cosmological Time Dilation and the SN1A Explosion. Open Access J Phys Sci. 2026. 3(2): 1-6. DOI: doi.org/10.61440/OAJPS.2026.v3.41

younger ones.

3. **Distance:** For galaxies with the same mass and the same age, the more distant ones should present a LARGER redshift. This should occur because the time the photon takes to reach Earth is longer for larger distances and, thus, we (and our measuring instruments) become smaller (because of a longer contraction time) and will measure the redshift with larger sizes.

Dark Matter

We know that the farther a star is from the center of the galaxy, from its nucleus, the smaller the gravitational field acting on it will be. Thus, according to DUT, the redshift of these stars should be larger than that of stars that are closer to the center.

Since, in DUT, smaller gravitational fields provide a smaller shrinking rate, those distant stars contract more slowly than stars closer to the nucleus. This causes their photons to present a larger wavelength (appearing to indicate a larger velocity).

On Earth, this increase in redshift for more distant stars is erroneously interpreted as a larger translational velocity. In order to correct this discrepancy in the velocity calculated from redshift, the need for DARK MATTER was postulated. Within DUT, this may instead be interpreted, just like dark energy, as another apparent effect.

Relativity Theory (RT) and DUT

Suppose DUT is correct. In that case, Relativity Theory would be incompatible with it (or incomplete) because it does not predict the CONTINUOUS shortening of space by the gravitational field.

What does that mean?

It means that if DUT (or another theory) uses some formula from RT, that theory may introduce inconsistencies, that is, it could be compromised by using a formula from a theory that is incomplete for this purpose and would therefore have a good chance of becoming compromised as well.

We should remember that RT does not explicitly address these effects within its standard formulation:

1. It is incompatible with quantum mechanics
2. It does not explain so-called "Dark Energy" (which violates the principle of energy conservation)
3. It does not explain "Dark Matter"
4. It does not resolve the relativistic train paradox [3]

For these reasons, DUT also avoids relativistic formulas in its basic mathematical structure.

Further ahead, we will verify how relativistic time contraction together with cosmological dilation affects the total time in the gravitational environment.

Some Nomenclatures

In our first basic article we used some nomenclatures that were later changed to make them compatible with nomenclature used in astronomy. We extract the following passage from the original article [4]:

"Let's call "Local Space" (="LS") the region of space that is subject to a non-negligible gravitational field and thus suffers spatial contraction. Let's call "Local Observer" (="LO") the observer who belongs to an "LS" and therefore is subject – he and his instruments – to spatial contraction. For example, planet Earth is an "LS" and we are "LO". Let's call "Outer Space" (="OS") the region of space that is subject to a very weak and negligible gravitational field. Let's call "Sidereal Observer" (="SO") those observers located in this spatial region. For example, observers in the intergalactic region would be in an "OS"."

Therefore, our comoving observer is the same as the "SO" (Sidereal Observer), and our proper observer is equivalent to the "LO" (Local Observer).

Time

We have seen that, according to DUT, distances in a gravitational field are contracted relative to a comoving observer (reference frame where the gravitational field is negligible). But we must also ask:

"How is time affected by the gravitational field?" Or, more objectively: "Is the measurement of time also affected by the gravitational field? How?"

The answer is YES. The measurement of time is affected by the gravitational field, and we will calculate this effect relative to "comoving time" (time measured by a sidereal observer where g is negligible). Next, we will see how this effect can be superposed on the time dilation caused by the gravitational field in Relativity Theory (RT).

The measurement of time, just like the measurement of distance, is always taken as a function of a given physical standard. In our case this standard is the modern physical definition of the second.

The Second

The second is defined as: "The duration of 9,192,631,770 (= Nc) periods of the radiation corresponding to the transition between two hyperfine levels of the ground state of the cesium-133 atom" [5].

This is equivalent to saying: "The duration of one period of cesium-133 radiation corresponds to the time it takes light to travel one single wavelength of that radiation, and this period is equal to 1/Nc of a second."

Let us compare two standards (scales or systems of measurement) as if they were, for example, the Decimal Metric System (meter, cm, kg) and the British/American Imperial System (inch, pounds).

To avoid confusion, we shall explicitly separate the measurement zunits from the numerical value of the measurement:

$$Measurement = (numerical\ value) \times (unit\ of\ measurement)$$

For example, the speed of light c will be written as:

C = C × m/s (≈ 300K × meters/second)

We will also define some nomenclatures and symbols:

Nomenclatures and Symbols

S0 = unit of time (second) in the comoving reference frame
m0 = unit of distance (meter) in the comoving reference frame (Δt = 0)
St = unit of time (second) in the gravitational (proper) reference frame
mt = unit of distance (meter) in the gravitational (proper) reference frame
Nc = 9,192,631,770 (number of cycles that make up 1 second)
H0 = Hubble constant (2.2E-18 s^-1)
Δt = period of contraction of the proper reference frame relative to the comoving one
Z = exp(H0 × Δt) (contraction factor)
C0 = speed of light in the comoving reference frame
Ct = speed of light in the proper reference frame

Lengths and Measurements

From our *primordial hypothesis,* we know that *distances contract continuously in a gravitational field* (~7% every billion years here on Eart). We define that at **Δt = 0** the measurement standards in both reference frames were the same. Naturally, the unit of distance will also decrease with time relative to the comoving reference frame (the platinum bar that defines the meter is shrinking). Thus, we may write:

$$m_t = \frac{m_0}{\exp(H_0 * \Delta t)} = \frac{m_0}{Z} [FT1]$$

The unit of distance in the proper reference frame decreases with time.

We may observe that at the beginning of time measurement, before contraction (Δt = 0), the units of distance were the same in both the comoving and proper reference frames:

$$\Delta t = 0 \rightarrow Z = 1 \rightarrow m_0 = m_t$$

We must keep in mind that *an observer in the proper environment does not perceive his own decrease in size when measuring distances in his own contracting reference frame,* because his measurement standard (for example, the meter) **decreases in the same proportion as the objects and distances being measured.**

That is, if L is the measurement of the **same distance or object at time t, its numerical measurement does not change with time.** In other words, in measuring the same object at different times, what **changes is the metric unit,** not the measured numerical value of the object itself. Therefore, we may write:

$$If : L(t_1) = L_1 * m_{t1} \; e \; L(t_2) = L_2 * m_{t1}$$
$$then : \rightarrow L_1 = L_2 \qquad [FT2]$$

numerical values measurements of distance of the same object do not change with time.

One Second

As seen above, the second is defined as the time it takes light to traverse Nc wavelengths of Cesium-133. That is:

$$1s = (N_c * \lambda) / c \quad [FT3]$$

Definition of the second.

In the comoving reference frame:

$$1S_0 = (N_c * \lambda_0) / c_0 \quad [FT4]$$

Where:

$$\lambda_0 = \lambda_0 * m_0$$
$$C_0 = C_0 * m_0 / S_0$$

In the proper reference frame:

$$1S_t = (N_c * \lambda_t) / c_t \quad [FT5]$$

Where:

$$\lambda_t = \lambda_t * m_t$$
$$c_t = c_t * m_t / S_t$$

The Measurement of the Speed of Light

From [FT4] we derive: $c_0 = N_c * \lambda_0 \quad [FT6A]$

From [FT5] we derive: $c_t = N_c * \lambda_t \quad [FT6B]$

But, as seen above in [FT2], the numerical values of distances do not change with time and, therefore:

$$\lambda_0 = \lambda_t \quad [FT7]$$

The numerical value of the wavelength does not change with time.

We may conclude, from [FT6] and [FT7], that:

$$C_0 = C_t \quad [FT8]$$

The numerical value of the speed of light is invariant in time. (Numerically, Nc · λ0 = (9192631770) × 0.0326 = 299679795)

Measurements of a Physical Event

Let us now measure the duration and distance of the same physical event with two observers (the comoving observer and the proper observer).

We must keep in mind that, since it is the same physical event, the physical quantities of duration (time) and distance are the same for both observers; what changes between them are their scales of time and distance measurement.

That is, when the scales are converted, when the measurements are converted from one environment to the other, we must obtain the same physical values.

Consider the event as the passage of a photon across a certain distance. This event will be measured in both reference frames.

$$/ ------- \sim\rightarrow ------ /$$
$$/ ---- < L_0, T_0 > ---- /$$

Event: A photon traverses a distance D0 in time T0

Comparing distances

In the comoving reference frame, we have:

$L_0 = L_0 * m_0$

$T_0 = L_0 / C_0 = (L_0 / C_0) * S_0 \qquad [FT9A]$

In the proper reference frame, we have:

$L_t = L_t * m_t$

$T_t = L_t / C_t = (L_t / C_t) * S_t \qquad [FT9B]$

Since it is the same physical event, when converting from one unit of measurement to another (from the comoving scale to the proper scale and vice versa), we must obtain the same physical values. That is:

The physical length traversed is the same → $L_0 = L_t$ [FT10]

$L_0 = L_t \rightarrow L_0 * m_0 = L_t * m_t$

However, from [FT1] we know that: $m_0 = Z * m_T$

Hence, as expected:

$L_t = L_0 * Z \qquad [FT11]$

The numerical of the proper value is greater than the numerical of the comoving value.

Comparing times

Since it is the same physical event, the time is the same when converted from one scale to the other (for example: 1h = 60s) then :

$T_0 = T_t \qquad [FT12]$

The physical time elapsed is the same

From [FT9A] and [FT9B] we have:

$(L_0 / C_0) * S_0 = (L_t / C_t) * S_t \qquad [FT13]$

Therefore:

$S_t / S_0 = (L_0 / C_0) * (C_t / L_t) \qquad [FT14]$

But from [FT11], $L_t = L_0 * Z$, so:

$S_t / S_0 = C_t / C_0 * (1/Z) \qquad [FT15]$

Since from [FT8], $C_0 = C_t$, we finally obtain the relation between the time units:

$S_t = S_0 / Z \qquad [FT16]$

Relation between the Proper Time unit and the Comoving Time unit

In generic form, if we measure a time T0 in the comoving reference frame, that is: $T_0 = T_0 * S_0$

And if we use [FT16], we obtain:

$T_0 = (T_0 * Z) * S_t$

But in the proper reference frame: $T_t = T_t * S_t$

$T_t = T_t * S_t = (T_0 * Z) * S_t$

Therefore, we finally obtain:

$T_t = Z * T_0 \qquad [FT18]$

The numerical value of proper time is greater than the numerical value of comoving time.

Where:

Tt = numerical value of the time measurement in the proper (gravitational) reference frame

T0 = numerical value of the time measurement in the comoving (non-gravitational) reference frame

Z= exp(H0 · Δt), contraction factor due to the gravitational field

Formula [FT18] above means that we measure a TIME DILATION in the comoving reference frame relative to the proper reference frame. That is, we measure a larger time (the number of measured time units is larger in the local frame) in the proper reference frame than in the comoving reference frame.

The Speed of Light

We may now compare the speed of light in the two reference frames.

In the proper reference frame, by definition:

$C_t = C_t * m_t / s_t$

But from $[FT08] C_0 = C_t$

$[FT1] m_0 = Z * m_t$

$[FT16] S_0 + Z * S_t$

It follows that:

$C_t = C_0 * m_0 / S_0 = c_0$

Therefore:

$C_t = C_0 \qquad [FT19]$

The speed of light is invariant in both reference frames.

Cosmological Time Dilation and Redshift (Z)

As a particular case, we may study how the time scale varies with redshift. The idea is to associate the distance of a star or galaxy with the time its light takes to reach Earth and with the change of the measurement and time scales during that interval.

The time that information, carried by light from a distant star, takes to reach us may be large enough for this dilation to be perceived.

Let us consider a star at a distance L measured from Earth, or L_0 measured by a comoving observer.

From our previous article [04], we copy formula [F03], which relates the wavelength in the proper and comoving reference frames:

$\lambda_t = \lambda_0 * \exp(H_0 * \Delta t) \qquad [FR01]$

Wavelength in the proper reference frame.

But by definition:

$Z = (\lambda - \lambda_0) / \lambda \qquad [FR02]$

Redshift Definition

From [FR01] and [FR02], we obtain:

$Z + 1 = \exp(H_0 * \Delta t) = Z \qquad [FR03]$

Now we may write the time relations between scales as a function of redshift:

Using [FR03] and [FT18] above, we finally derive the famous "cosmological time dilation" [5-7]:

$$T_t = (Z+1)T_0 \qquad [FR04]$$

COSMOLOGICAL TIME DILATATION

This formula shows that the time measurement in the proper reference frame (Earth) is greater than the time measurement in the comoving reference frame. There is a dilation of comoving time relative to proper time.

Some Physical Considerations

The reader may ask whether these two standards of measurement are merely a change of scales, such as meters to yards or minutes to hours, or whether they reflect something deeper, such as our lifetime or whether physical processes in the reference frames actually take different times. The answer is: yes, are measured as occurring more rapidly relative to a comoving observer.

However, we must be careful: if we measure the time of a standard physical process at different time scales in our own proper reference frame, we will not measure differences in time. We will not measure a difference because our own time standard is changing in the same proportion. That is: physical processes are measured as proceeding more rapidly when compared to a comoving reference frame, but our clock also runs more rapidly.

Relativity Theory

We may perceive that DUT predicts something opposite to Relativity Theory (RT). But, in fact, as we will see, there is no contradiction. DUT deals with time in a way that is perceived only on cosmological scales, of many millions of years. In RT, the effect is instantaneous and non-cumulative: the variation in time is fixed and does not depend on how long we take to measure it.

In DUT, the temporal variation depends on how long we take to measure it, because the time unit gradually and continuously decreases relative to the comoving reference frame.

Type Ia Supernova Explosion (SN1A)

We may think of SN1A as the "TICK-TOCK" of a cosmological clock:

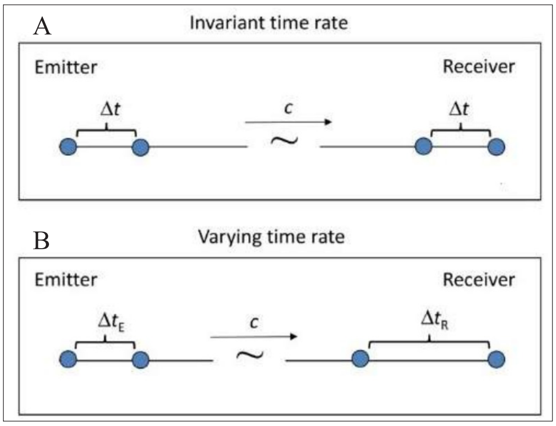
When the SN1A begins to explode, this represents the "TICK" of the clock, and when it finishes exploding, that represents the "TOCK".

For an SN1A closer to us, the light photon takes less time to arrive, so its "TICK-TOCK" will have a shorter period than that of a more distant SN1A.

For the signal (light) to reach us, the longer it takes, the faster our clocks will be, and thus we will measure their "TICK-TOCK" as even slower.

This relation [FR04], which derived temporal dilation with increasing distance or redshift, explains **the increase in the observed explosion time of Type Ia supernovae SN1A** with distance from Earth. ***It has been extensively verified that the explosion time, measured from Earth, grows with the factor (1+Z),*** and this is not directly derived within standard relativistic formulations.

Several articles illustrate this:



"Goldhaber et al. analysed SN Ia light curves for 35 high-redshift SNe with z < 0.8 discovered by the Supernova Cosmology Project (SCP) and 18 low-redshift SNe with z < 0.11. The data were aligned, normalized, and K-corrected to establish a common rest-frame B-band curve. Comparing the light curves of individual SNe with this reference curve confirmed the presence of cosmic time dilation, with a time-stretch factor of 1 + z." [10]

"The cosmic time dilation observed in Type Ia supernova light curves suggests that the passage of cosmic time varies throughout the evolution of the Universe. This observation implies that the rate of proper time is not constant, as assumed in the standard FLRW metric, but instead is time-dependent." [11]

"This work is based on the first results from a systematic search for high redshift Type Ia supernovae. Using filters in the R-band we discovered seven such SNe, with redshift z = 0.3–0.5, before or at maximum light. Type Ia SNe are known to be a homogeneous group of SNe, to first order, with very similar light curves, spectra and peak luminosities. In this talk we report that the light curves we observe are all broadened (time dilated) as expected from the expanding universe hypothesis. Small variations from the expected 1+z broadening of the light curve widths can be attributed to a width-brightness correlation that has been observed for nearby SNe (z<0.1). We show in this talk the first clear observation of the cosmological time dilation for macroscopic objects." [12]

Thus, DUT provides an alternative interpretation of time dilation with the factor (1+Z) in the explosion of Type Ia SN1A supernovae.

Cosmological Time Dilation and Relativity Theory

In Relativity Theory, time dilation in a gravitational field may be written as:

$$T_{RG} = \frac{T_0}{\sqrt{1-\frac{2GM}{rc^2}}}$$

where T_0 is the time measured by a distant observer and T_RG is the time measured in the gravitational environment.

In DUT, as shown earlier, the temporal variation associated with the contraction of physical scales is given by [F8]:

$$T_{DUT} = T_0 \exp(H_0 \Delta t) = T_0 * (1+Z)$$

If we consider that both effects act simultaneously, the total time variation may be written as:

$$\frac{T'}{T_0} = \frac{1+Z}{\sqrt{1-\frac{2GM}{rc^2}}}$$

showing that time dilation then depends both on the local gravitational field and on the accumulated cosmological time.

Balance Between Gravitational Time Dilation (RT) and DUT Time Scaling

In this section, we estimate the timescale required for the temporal variation predicted by DUT to compensate for the gravitational time dilation predicted by Relativity Theory (RT) at the Earth's surface.

According to RT, the proper time measured at a radial distance r from a mass M, relative to a distant (comoving) observer, is given by:

$$\frac{T_{Terra}}{dx} = \sqrt{1-\frac{2GM}{rc^2}}$$

This factor is smaller than unity, indicating that clocks in a gravitational field run more slowly relative to a distant observer.

In contrast, within DUT, the temporal variation relative to the comoving frame is given by:

$$\frac{T_{Terra}}{Tcomovel} = e^{H0\Delta t}$$

where H0 is the Hubble constant and Δt is the cosmological time interval.

Assuming that both effects act simultaneously and independently, the combined temporal factor is given by the product:

$$e^{H_0\Delta t}\sqrt{1-\frac{2GM}{rc^2}}$$

The condition for exact compensation between the two effects is therefore:

$$e^{H_0\Delta t}\sqrt{1-\frac{2GM}{rc^2}} = 1$$

Solving for Δt, we obtain:

$$\Delta t = -\frac{1}{2H_0}\ln(1-\frac{2GM}{rc^2})$$

For weak gravitational fields $(\frac{2GM}{rc^2} << 1)$ we use the approximation: ln(1 − x) ≈ −x

obtaining:

$$\Delta t \approx \frac{GM}{rc^2 H_0}$$

Substituting the physical parameters of the Earth:

$G = 6.674\times10^{-11} m^3 kg^{-1} s^{-2}$,

$M = 5.972\times10^{24} kg$,

$r = 6.371\times10^{6} m$,

$c = 2.998\times10^{8} m/s$

and adopting: $H_0 \approx 2.2\times10^{-18} s^{-1}$

we obtain: $\frac{GM}{rc^2} \approx 6.96\times10^{-10}$

and therefore: Δt ≈ 3.16 × 10^8 s ≈ 10 years

Interpretation

This result indicates that, within DUT, the cumulative effect of temporal variation becomes comparable in magnitude to gravitational time dilation at the Earth's surface after approximately 10 years.

In other words, while RT time dilation is a fixed local effect determined by the gravitational potential, DUT predicts a continuous temporal evolution. After a sufficiently long cosmological interval, the DUT contribution may effectively compensate for the relativistic effect when both are compared relative to a comoving reference frame.

Conclusion

Using the concepts and formulas of the Decreasing Universe Theory (DUT), we showed that “Cosmological Time Dilation” does in fact exist and can be derived from the equations and concepts of DUT. Moreover, the results match the various observations made using the measured duration of Type Ia supernova explosions. This result further strengthens the robustness of this new theory.

References

1. Jocaxian Nothingnesshttps://medcraveonline.com/AAOAJ/the-jocaxianrsquos-nothingness.html
2. Derivation of Hubble’s Law and its relation to dark energy and dark matter https://medcraveonline.com/OAJMTP/OAJMTP-02-00049.pdf
3. Jocaxian's Train #1
4. https://www.omicsonline.org/open-access-pdfs/jocaxians-train-2476-2296-1000154.pdf
5. Decreasing universe: the distance as a function of redshift https://medcraveonline.com/AAOAJ/AAOAJ-09-00220.pdf
6. Cosmic Time Dilation https://ui.adsabs.harvard.edu/abs/1997ApJ...482L.115S/abstract
7. Astronomers observe time dilation in early universe https://www.theguardian.com/science/2023/jul/03/astronomers-observe-time-dilation-in-early-universe
8. Time dilation finally observed in quasars https://cerncourier.com/a/time-dilation-finally-observed-in-quasars/
9. Time Dilation Observed in Type Ia Supernova Light Curves and Its Cosmological Consequences https://www.mdpi.com/2075-4434/13/3/55
10. Observation of cosmological time dilation using Type Ia supernovae as clocks https://ui.adsabs.harvard.edu/abs/1997ASIC..486..777G/abstract
11. Time dilation observed in Type Ia supernova light curves and its cosmological consequences https://arxiv.org/html/2506.19099v1#:~:text=We%20conclude%20that%20the%20gravSecond https://en.wikipedia.org/wiki/Second
12. DUT: Main Published Papers. https://jocaxx.github.io/DUniverse/Articles.pdf