A Case Study of Closed Universe that Fits the Cosmological Data of Supernovae of Type Ia

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Abstract. In this paper a case study of an homogeneous and isotropic expanding space-time that expands via expansion of its basic element raises a fundamental distinction between recession movement of matter and space expansion. We prove that observing matter recession at an accelerating rate is not an indication for the acceleration of the universe expansion. More precisely, we show that the observed acceleration in the recession movement of galaxies is naturally due to the space-time deceleration. The case study provides us with a possible space-time with independent movement that might produce the observed behavior of galaxies registered for the redshift \( z < 0.5 \) as well as for the redshift \( z > 0.5 \). This case study calls into question the recent interpretation of the accelerating recession movement of galaxies as indication for the universe acceleration.

1. Introduction

It was observed and confirmed that distant supernovae (SNe) of type Ia appear dimmer than expected in a supposed matter dominated space ([9],[10],[8]). Cosmologists are led to the conclusion that the recent expansion of the universe has definitely been starting accelerating for approximately 5 billion years. The SNe observations convey a shocking reverse of image about our universe understanding, from a matter dominated space to a vacuum dominated space, with a reference to the existence of vacuum energy that generates this acceleration, accounting for about 73% of the universe total density of energy. The SNe results combined with galaxies clustering and the cosmic microwave background data were interpreted in terms of concordance in favor of a flat and accelerating universe expansion. It is out of the scope of this article to discuss the reliability and robustness of the observational measurements and data. However, the use of reliable interpretations of the observational data measurements and their physical properties in developing a lucid understanding of our universe global dynamic is a matter of questioning. The strict application of the cosmological principles, such as homogeneity and isotropy, has encouraged astrophysicists to relate local properties of the observable universe to global properties of the whole universe. There is no dispute in considering the observed movement of galaxies, in the visible universe, as a consequence of the universe expansion, however to identify the observed matter movement with the whole universe dynamic is the real problem. G. Lemaitre (1927, [5]) was the first who related the observed movement of galaxies to the space expansion. More precisely, the observed recession movement of galaxies does not correspond to the proper movement of galaxies: the whole space-time is stretched in all direction, which creates the space-time expansion, and then induces the observed recession movement of galaxies.
from each other. Galaxies might have a relative motion to others galaxies with a velocity called peculiar velocity that is randomly oriented. The measured recession velocity of galaxies cannot be split into the peculiar velocity and the space-time expanding velocity, however the peculiar velocity is neglected in cosmology since it is randomly oriented and it is independent of the space-time motion, meanwhile the space-time expanding velocity at large distance has a dominant magnitude since it is proportional to distance. A case study of an homogeneous and isotropic expanding space-time that expands via expansion of its basic elements is introduced in this paper that fits all the astronomical observations, data and measurements, such as those from distant supernovae of type Ia, cosmic microwave background radiation, and galaxy clustering. This case study might reveal a different interpretation to the recent rewarded one.

2. The case study introduction

To understand and identify the eventual characteristics and effects of alternative conditions and course of transformation that define the mechanism of an homogeneous and isotropic expanding space-time, a case study was introduced in [1] that simulates and reproduces an expanding space-time compatible with the principles of cosmology using a discrete expansion of the space-time via simultaneous expansion of its basic elements as open balls. The primordial space in the case study consists of an Euclidian space-time $M_0$ with zero curvature, set of accumulated points without depth, where $M_0$ expands via simultaneous expansion of its basic elements, by increasing simultaneously their depth in all directions as expanding open balls (see Fig.1). An infinite family of packed expanding open balls is obtained that models the observed expansion in all directions. Taking into account the density of the space-time, other new basic elements with different sizes will expand in any interstice, which creates an Apollonian gasket of packed expanding balls with different sizes. The appearance of Apollonian gasket between any three packed basic elements creates the fractal character of the space-time and simulates locally the expanding balls with different sizes. The appearance of Apollonian gasket between any three packed basic elements creates the fractal character of the space-time and simulates locally the non homogeneity of the expanding space-time; meanwhile the simultaneous expansion of the primordial basic elements simulates the homogeneity and isotropy of the expanding space-time at large scale. Matter is located on the surface of the packed spheres, and since matter exists in 4 dimensional space-time then the surface of each expanding spheres illustrates a distortion of 4 dimensional space-time. To simulate the evolution of the expanding space-time $M_0$ we define a discrete expansion by using a quantified expansion indexed by $n \geq 0$, where the primordial space is obtained for $n = 0$ denoted by $M_0$, and as $n$ increases the space-time $M_n$ expands by increasing the radius of its basic elements simultaneously step by step to reach the present space-time at the step$(n)$. The step expansion of the basic elements of the space-time $M_0$ is defined as follow:

**Definition 1** ([1]) Let $P_0$ be a primordial basic element of the expanding space-time $M$ at the step$(0)$, and $P_n$ be its representation in $M$ at the step$(n)$ for all $n > 0$. The expansion of the basic element $P_n$ verifies:

i) for all $n > 0$, $P_n$ is approximated by an expanding open ball.

ii) for all $n \geq 0$, $P_n \subset P_{n+1}$.

iii) for all $n > 0$, any non empty subset $S_n$ of $P_n$ expands symmetrically in all directions into a subset $S_{n+1}$ of $P_{n+1}$ such that $S_n \subset S_{n+1}$.

The increase of the distance between any two distant basic elements of the discrete expansion of the space time $M$ is quantified from the step$(1)$ to the step$(n)$ as follow:

**Definition 2** ([1]) Let $P_n$ and $Q_n$ be two distant basic elements of the expanding space-time $M$ at the step$(1)$ with distance $L_1 > 0$. Let $P_n$ and $Q_n$ be their respective representation at the step$(n)$ for all $n > 1$. The distance between $P_n$ and $Q_n$ at the step$(n)$ is defined by $L_n$ for all $n > 1$ such that

$$L_n = a_n L_{n-1}, \quad \forall n > 1$$  \hspace{1cm} (1)
where the sequence \((a_i)_{i \geq 1}\) satisfies the following conditions:

i) for all \(i > 1\), \(a_i > 1\),

ii) for all \(i > 1\), \(a_{i+1} < a_i\),

iii) the product \(\prod_{i=1}^{n} a_{i+1}\) is convergent,

for \(a_1 = 1\) we have: \(L_n = L_1\left(\prod_{i=1}^{n} a_i\right)\), \(\forall n \geq 1\), we call \(a_i\) the \(i^{th}\) step-expanding parameter and \(\prod_{i=1}^{n} a_i\) the expanding parameter at the step \(n\).

The dimension of the simulated expanding space-time \(\mathcal{M}_n\) with matter at the step \(n\) is \(4 + n\) for all \(n \geq 0\). Galaxies will be illustrated in this case study as dots on the surface of an infinity of packed spheres (see Fig.1).

Figure 1. A portion of packed expanding basic elements at the step \(n\) from the Big Bang, where matter is illustrated as dots on a distorted 4 dimensional space-time reduced to a surface in this figure.

Figure 2. The same portion of packed expanding basic elements with matter and invisible geometry (1). Matter appears to be held in the expanding space-time with no visible pillars that one can see.

3. Incorporation of data from supernovae of type Ia in the case study

3.1. Incorporation of accelerating and decelerating expansion on one sphere

One sphere among the infinity of packed spheres in this case study conveys the dynamic of the whole expanding space-time, indeed if each sphere has an accelerating or decelerating expansion, the whole space-time will have the same nature of expansion. It is then sufficient to simulate the acceleration and deceleration on one sphere to figure out the dynamic of the space-time expansion. Matter exists in 4 dimensional space-time, and the surface of the packed expanding spheres illustrates a distortion of the 4 dimensional space-time. In this case study the width of the distorted 4 dimensional space-time in one sphere is neglected with respect to a very large radius, then the distance between two distant galaxies can be approximated by the multiplication of the central angle \(\theta(t)\) and the radius of the expanding sphere. In this case study a packed expanding sphere \(S\) has a radius given by

\[
R(t) = k(1 - e^{-at^2}),
\]  

(2)
with \( k > 0 \) an arbitrary constant, \( a > 0 \). The expansion velocity of the sphere \( S \) is given by \( R'(t) = 2a k e^{-at^2} \geq 0 \), and the acceleration of the sphere expansion is given by \( R''(t) = 2a ke^{-at^2}(1 - 2at^2) \). Then

\[
\begin{cases}
R''(t) > 0, & \text{for } 0 < t < \frac{1}{\sqrt{2a}}, \quad \text{accelerating expansion of } S \\
R''(t) < 0, & \text{for } t > \frac{1}{\sqrt{2a}}, \quad \text{decelerating expansion of } S
\end{cases}
\tag{3}
\]

### 3.2. Accelerating and decelerating recession movement of matter on one sphere

The expanding distance \( L(t) \) between galaxies on the sphere \( S \) depends on the variation of the radius \( R(t) \) of \( S \) and on the central angle \( \theta(t) \). Indeed,

\[
L(t) = R(t) \theta(t)
\tag{4}
\]

where the central angle \( \theta(t) \) is a positive function that has a differential of second order. The recession velocity of galaxies on \( S \) is then expressed by

\[
V(t) = \frac{dL(t)}{dt} = R'(t)\theta(t) + R(t)\theta'(t).
\tag{5}
\]

The distance between two galaxies on the sphere is given by \( L(t) = k(1 - e^{-at^2})\theta(t) \) using (2) in (4), and the recession velocity (5) is given by \( V(t) = \frac{dL(t)}{dt} = 2k a e^{-at^2}\theta(t) + k(1 - e^{-at^2})\theta'(t) \), where the acceleration of the recession movement of matter is described by

\[
\Gamma(t) = \frac{dV(t)}{dt} = R''(t)\theta(t) + 2R'(t)\theta'(t) + R(t)\theta''(t).
\tag{6}
\]

Using (2) in (6) gives

\[
\Gamma(t) = 2k a e^{-at^2}(1 - 2at^2)\theta(t) + 4k a e^{-at^2}\theta'(t) + k(1 - e^{-at^2})\theta''(t).
\tag{7}
\]

We denote (7) by

\[
\Gamma(t) = \Gamma\left(t, \theta(t), \theta'(t), \theta''(t)\right).
\tag{8}
\]

If galaxies are fixed on the surface of the expanding sphere, then any central angle \( \theta(t) \) between galaxies and the sphere center remains constant as the sphere expands. The substitution of \( \theta(t) = \theta_0 = \text{cst} \) in (7) gives

\[
\begin{cases}
\text{For } R''(t) > 0, & \implies \Gamma\left(t, \theta_0, 0, 0\right) > 0 \\
\text{For } R''(t) < 0, & \implies \Gamma\left(t, \theta_0, 0, 0\right) < 0
\end{cases}
\tag{9}
\]

which means that if the space has an accelerating expansion, the recession movement of galaxies will accelerate, and if the space has a decelerating expansion, the recession movement of galaxies will decelerate, in this case the movement of matter is an indication of the space movement with same nature. However the case \( \theta(t) = \text{cst} \) must be excluded in this case study since matter is free of movement in the universe based on observation. To simulate an acceleration in the recession movement of galaxies as the space expansion decelerates, as well as a deceleration in the recession movement of galaxies as the space accelerates (Fig.3, Fig.4), it is sufficient to find a variable central angle \( \theta(t) \) solution of the second order differential inequality \( \Gamma\left(t, \theta(t), \theta'(t), \theta''(t)\right) > 0 \) (respectively \( \Gamma\left(t, \theta(t), \theta'(t), \theta''(t)\right) < 0 \) that corresponds to an accelerating (respectively decelerating) recession movement of matter. The solutions of these inequalities are families of functions \( \theta(t) \). Thus it will be satisfactory to provide one solution for each inequality that matches our objectives.
increases
\( t \theta \)

\( t \theta \)

decreases
\( t \theta \)

3.2.1. Solution for an accelerating recession movement in a decelerating expanding space

Using equation (3), the deceleration period of the expanding sphere \( S \) of radius (2) corresponds to the period \( t > \frac{1}{\sqrt{2a}} \), and an accelerating recession movement of galaxies during that period can be obtained by solving the second order differential inequality:

\[
\Gamma \left( t, \theta(t), \theta'(t), \theta''(t) \right) > 0, \quad \forall t > \frac{1}{\sqrt{2a}},
\]

(10)

The solution set of (10) is a family of functions

\[
\left\{ \theta(t) / \forall t > \frac{1}{\sqrt{2a}}, \quad \Gamma \left( t, \theta(t), \theta'(t), \theta''(t) \right) > 0, \quad \theta'(t) > 0, \quad \theta(t) > 0 \right\}
\]

(11)

and the solution set is not empty since \( \theta(t) = t^2 \) is a solution of (10). Indeed, for \( \theta(t) = t^2 \), the equalities (7) and (8) give \( \Gamma \left( t, t^2, 2t, 2 \right) = 2ke^{-at^2}(1 - 2at^2)t^2 + 8kat^2e^{-at^2} + 2(1 - e^{-at^2}) \), then \( \Gamma \left( t, t^2, 2t, 2 \right) = 2ke^{-at^2}(-2a^2t^4 + 5a^2t^2 - 1) + 2k \), where the sign analysis of \( \Gamma' \left( t, t^2, 2t, 2 \right) \) yields \( \Gamma \left( t, t^2, 2t, 2 \right) > 0 \) for all \( t > 0 \). More precisely using (3) we have \( R''(t) < 0 \), and \( \Gamma \left( t, t^2, 2t, 2 \right) > 0 \), for \( t > \frac{1}{\sqrt{2a}} \), which simulates the current observed accelerating recession movement of matter in a decelerating expanding space time.

3.2.2. Solution for a decelerating recession movement in an accelerating expanding space

The SNe data [10] favor a recent acceleration for the redshift \( z < 0.5 \) and a past deceleration for the redshift \( z > 0.5 \), hence cosmologists have estimated that this acceleration began approximately 5 billion years ago and that the universe was decelerating before that period. In order to make the case study matching the real data of SNe of Type Ia for the redshift \( z < 0.5 \) as well as for the redshift \( z > 0.5 \), it is sufficient to put \( \frac{1}{\sqrt{2a}} = (T_0 - 5) \text{ Gyr} \), where \( T_0 \) is the age of the universe. If the age of the universe is estimated today up to \( T_0 = 14.5 \text{ Gyr} \), then \( \frac{1}{\sqrt{2a}} = 9.5 \text{ Gyr} \) and \( a = \frac{1}{180} \). The value of \( a \) can change following the estimated age of the universe, as well as the inflection point between the acceleration and deceleration periods. Using equation
3.3. The case study and observation

This case study describes the observed movement of matter in our universe for the redshift $z > 0.5$ as well as for the redshift $z > 0.5$, and sets two movements apart: the recession movement of matter and the space expanding movement (Fig. 5). When the universe expansion is accelerating, the observed recession movement of matter is decelerating, and when the universe expansion is decelerating, the observed recession movement of matter is accelerating. A rational relation between the two opposite motion can be found.

![Figure 5](image-url)
3.3.1. Effect of universe acceleration/deceleration on matter Since galaxies in our universe are free in their position, they can have their proper movement under any external force. Moreover if the space between galaxies is stretched under an accelerated or decelerated space expansion, then there must exist an inertial force due to the galaxies resistance to the universe accelerated or decelerated expansion. This inertial force located in galaxy center depends on galaxy mass and universe acceleration/deceleration. This inertial force is denoted by $F_i$ and is given by the magnitude

$$F_i = (\text{Galaxy Mass}) \times (\text{Universe Acceleration}).$$

The existence of this inertial force may provide a rational explanation of the observed acceleration of recession of galaxies at the redshift $z < 0.5$ in a decelerating space, as well as a rational explanation for the past deceleration at the redshift $z > 0.5$ in an accelerating space. Indeed, one has $R''(t) > 0$ and $\Gamma(t, t_0, 1 - \alpha t, -\theta_0\alpha, 0) < 0$, for $t_0 < t < \frac{1}{\sqrt{2a}}$, meanwhile $R''(t) < 0$ and $\Gamma(t, t^2, 2t, 2) > 0$, for $t > \frac{1}{\sqrt{2a}}$, that is to say:

- For $t_0 < t < \frac{1}{\sqrt{2a}}$, $F_i$ acts as a repulsive force to add a recession movement to galaxies other than the recession movement due to the space expansion, which induces the acceleration observed from earth (Fig. 7).
- For $t > \frac{1}{\sqrt{2a}}$, as the space starts decelerating, each galaxy is subject to the inertial force $F_i$ function of its mass and the space deceleration. The action of the inertial force is opposite to the space deceleration, and then this force will act as a repulsive force to add a recession movement to galaxies other than the recession movement due to the space expansion, which induces the acceleration observed from earth (Fig. 7). The effect of this inertial force on galaxies fits the observation of the accelerating recession movement of galaxies for the redshift $z < 0.5$.

Moreover, for $t_0 < t < \frac{1}{\sqrt{2a}}$, the space was accelerating, and the recession movement of matter was decelerating due to the action of the inertial force on galaxies (Fig. 6). The inertial force opposite to the universe acceleration pulls galaxies to each other, and together with the space expansion induces a decelerating recession movement of galaxies that corresponds to the one estimated to be happened in the past for the redshift $z > 0.5$.

3.3.2. Matter movement versus universe movement The recorded redshift and brightness of a distinguishable class of astronomical objects used as "a standard candle" fits the case study and leads to a rational interpretation concerning the change of accelerating recession movement of galaxies. Interpreting and identifying the recession movement of galaxies to the space-time movement provide a contradiction with this case study, indeed one can identify the space-time movement to the matter recession movement within this case study if the central angle between galaxies remains constant during the space expansion, which means that galaxies must be fixed in their location on the expanding space-time. However, this situation is not true since observation confirmed the free movement of galaxies in our space time. Indeed, galaxies might have a relative motion to others galaxies with a velocity called peculiar velocity that is randomly oriented and this peculiar velocity is neglected in cosmology since it is randomly oriented and it is independent of the space-time motion. Meanwhile the space-time expanding velocity at large distance has a dominant magnitude proportional to the distance that separate galaxies. Based in this case study all galaxies at large scale will have a well oriented free movement due to the inertial force (14) and this movement cannot be neglected because it is not randomly oriented and it depends on the space-time acceleration/deceleration. The case study does not question the data brought from supernovae observation of type Ia but it provides us with a new
Universe accelerating expansion

Figure 6. If the 2D space grid expands via simultaneous accelerating expansion of its squares, the two balls will feel an inertial force due to this acceleration. Observer on one ball will see the other ball receding with a decelerating recession velocity under the effect of the inertial force.

Universe decelerating expansion

Figure 7. If the 2D space grid expands via simultaneous decelerating expansion of its squares, the two balls will feel an inertial force due to this deceleration. Observer on one ball will see the other ball receding with an accelerating recession velocity under the effect of the inertial force.

interpretation of the observed acceleration of recession of galaxies, as well as a possible space with independent movement that might produce the observed behavior of galaxies registered for the redshift $z < 0.5$ as well as for the redshift $z > 0.5$.

3.3.3. Surface of Last Scattering: Global or Local View Everything in our universe is either matter/energy or radiation, the cosmic microwave background photons in our universe are the most ancient photons one can observe and measure since it is considered as a remnant of the Big Bang. Some information, such as the universe curvature and the universe density parameter, can be estimated straightforward from the measurement of the cosmic microwave background fluctuations. Measurement indicates that the geometry of our universe is approximately flat with an uncertainty of 2%, where the cosmological estimation of the density parameter is about $\Omega_0 = 1.02 \pm 0.02$, that is to say the density parameter $1 \leq \Omega_0 \leq 1.04$, which means that the universe geometry is nearly flat universe but not globally flat. The story might end here if the words ”not globally flat” have not been forgotten. The universe is considered as a flat universe but not locally flat, and many fundamental consequences result from this assertion. It is not matter of improving the quantities or the qualities of measurement, it is not matter of questioning the reliability of the CMB data or the methodology in finding the curvature of the observed universe, rather than questioning the global interpretation, and this is due to the following:

1) The space provided by the case study is given by an infinite number of packed spheres, the simultaneous expansion of spheres describes the space-time expansion. If each sphere was expanding since the beginning of the universe expansion (13.7 Billion years for example), an observer located on the surface of the sphere $S$ will have a visible horizon given by a sphere of radius 13.7 billion light years centered on the observer, and that sphere will never encompass the center the sphere $S$, otherwise the observer will see the beginning of the cosmological expansion.
That is why the CMB measurement and data is and will remain a local measurement and data, and the curvature provided by the CMB anisotropy is a local curvature that means the space is locally flat. However the global flatness of the universe is still unknown, and this will press to question the rational need for the existence of the dark energy if the acceleration of the recession movement of matter can be explained rationally by the existence of an inertial force due to galaxies resistance to the universe expansion.

2) Moreover, if one looks back to CMB data concerning the universe total density: the measurement of the universe density of matter from Boomerang-98 and Maxima ([6],[2]) gives: $0.85 < \Omega_{T_{tot}} < 1.25$, at 68% confidence level, and $0.88 < \Omega_{T_{tot}} < 1.12$, at 95% confidence level, where the average $\Omega_{Av} > 1$. The best fit from Wilkinson Microwave Anisotropy Probe (WMAP), ([11],[3],[4]) gives: $\Omega_{T_{tot}} = 1.02 \pm 0.02$, for 1 year data release, and $\Omega_{T_{tot}} = 1.099^{+0.100}_{-0.085}$, for 5 years data release, and $\Omega_{T_{tot}} = 1.080^{+0.095}_{-0.071}$, for 7 years data release, where the average $\Omega_{Av} > 1$. Meanwhile the WMAP data combined with measurement from supernovae Type Ia and from Baryon acoustic oscillation (BAO), ([3],[4]) gives: $\Omega_{T_{tot}} = 1.0050^{+0.0060}_{-0.0061}$, for 5 years data release, and $\Omega_{T_{tot}} = 1.0023^{+0.0056}_{-0.0085}$, for 7 years data release, where the average $\Omega_{Av} > 1$.

The classical calculus of average of the universe density data for all the measurement gives $\Omega_{Av} > 1$ which is in favor of a local spherical space rather than a flat space. Suggesting that the spatial curvature of the universe is very close to zero but not zero is not sustainable for a globally flat space. Nevertheless, the marge of error with respect to a totally flat universe with $\Omega_{T_{tot}} = 1$, as small as it is, allows to consider a spherical universe, as described by the case study, with very large radius. It is known that the normal curvature of a sphere of radius $R$ is everywhere and in all direction given by $R^{-1}$. The curvature is approximatively equal to zero for the visible horizon (large radius), that is to say the space illustrated in the case study is locally approximatively flat. The visible horizon centered on the Earth observer will appear locally flat regardless of the whole shape of the considered space, and the cosmic microwave background radiation detected on $S$ can not distinguish between the visible horizon on the sphere $S$ and a nearly flat space. Based on the case study matter location and movement are on the surface of packed spheres, the size of the visible horizon on one sphere is given by a sphere of radius one light year times the universe age. The visible horizon centered on an observer will never encompass the center of the considered sphere otherwise the observer would observe the beginning of the cosmic expansion in the CMB, which means that any CMB measurement is a local measurement with respect to the universe whole size.

4. Insight toward a better understanding of the universe dynamic and mechanism

The acceleration of matter recession in our universe is believed to be originated by the vacuum energy called Dark Energy as suggested by the Nobel’s Laureates ([7]), and the source of this dark energy remains a big mystery in our understanding of this cosmic phenomenon. Nevertheless, the suggestion of this mysterious energy is relatively needed in a simple picture of universe where the recession movement of matter reflects its mechanism, and it will be a just a question of time to find its source, origin and characteristics to build a rational understanding of it. However, no one can assert nowadays that what we observe today reflects really and surely the real universe mechanism. The case study raises interesting facts:

i) The recession movement of matter does not totally reflect the real nature of the space expansion, since the recession movement of matter can be accelerating while the expansion movement of the space is decelerating and the recession movement of matter can be decelerating while the expansion movement of the space is accelerating.

ii) The recession movement of matter is only a consequence of the space expansion, and observing galaxies receding from each other at an accelerating rate is not an indication that the space is expanding at an accelerating rate.
iii) There must exist an inertial force located in the center of each galaxy that represents the resistance of galaxies to the universe accelerating/decelerating expansion.

iv) The acceleration/deceleration of recession movement of matter on the space described in the case study is naturally due to the decelerating/accelerating expansion of the spheres radius.

vi) The notion "nearly flat" or "approximatively flat" with a small error does not address the real nature of the universe mechanism. If a small error to $\Omega = 1$ is neglected, then the existence of unknown energy that represents 73% of the critical density $\rho_c$ (density of matter in a flat universe) needs to be postulated to explain the suddenly accelerating recession movement of galaxies we observe today.

vii) The visible horizon centered on the observer is delimited by the size of the basic element of the space in the case study (the age of the universe can be determined with one sphere), otherwise observer would see the beginning of the cosmic expansion. Therefore the CMB data measurement is locally valid but globally not suitable to describe the characteristics of the whole universe.

The case study fits the cosmological principles (isotropy and homogeneity) and provides a space with radial expansion locally and different expansion globally, where the property of the whole universe resides in the property of one expanding sphere in it. This last property imposes a boundary to the visible horizon and makes all our measurements for the very large scale being local. Interpretation of the astronomical measurement and data in favor of a flat universe is not sustainable since it is not the unique interpretation that describes the cosmic phenomenon. Moreover, neglecting a tiny error, as small as it is, in a parameter that characterizes the whole universe leads to the need of a new energy, accounting for about 73% of the total energy density of the universe, as the only source of a negative pressure that explains the acceleration of matter recession we observe today after approximatively 9.5 billion years of expansion. The conclusion that the recent expansion of the universe definitely accelerates as well as the universe is flat seems not to be the only possible interpretation. Nevertheless, the recession movement of galaxies is definitely accelerating and the true mechanism of the universe is still missing in our understanding.

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