On how the Friedmann equations lead only to non-accelerating universes

Fernando Salmon
Physicist. Complutense University of Madrid.
Independent Researcher
fernandosalmoniza@gmail.com

Abstract

The controversy surrounding the existence of a non-accelerating universe—contrasting with the prevailing view of recent decades that we inhabit an accelerating, expanding universe—has resurfaced following recent discoveries by South Korean and Indian scientists. At the same time, the position held by U.S. scientists regarding an accelerating universe has been reaffirmed; the debate is likely to persist until more reliable data on dark energy become available in the coming years, ultimately settling the matter. The new Nancy Grace Roman Telescope, launched into orbit just weeks ago, is poised to resolve the issue in the near future. For now, new studies and opinions continue to emerge, supporting one position or the other. The work presented here is a theoretical study arguing for the existence of a non-accelerating universe; to this end, it examines the solutions to the Friedmann equations in detail. This study analyzes the expansion of the universe using a mathematical approach that leads to the following conclusion: the only valid solutions to the Friedmann equations are those describing non-accelerating universes.

Keywords: large-scale structure of Universe, cosmology: theory, Friedmann equations, FLRW metric

1. Introduction

For decades, the prevailing view within the scientific community has been that our universe is expanding at an accelerating rate (Riess A et al., 1998; Wiseman P et al., 2026). However, recent experimental studies (Junhjuk Son et al., 2025; Animesh Sah et al., 2026) appear to confirm that our universe shows no signs of acceleration—or is even contracting slightly; in other words, we may be living in a universe without acceleration. In this paper, we present evidence that this result aligns with the predictions of relativistic theory. To this end, we demonstrate—mathematically and through an analysis of the metric (using conformal metrics)—that the scale factor \$a(t)\$ exhibits zero acceleration; that is, its second derivative is equal to zero. Consequently, the only valid solutions to the Friedmann equations are those describing universes without acceleration.

Our method for demonstrating that the Friedmann equations lead exclusively to universes without acceleration is a mathematical proof based on topological considerations regarding the FLRW metric. We know that this metric is locally conformally flat (Masao I et al., 2007), a property that serves to demonstrate that it leads solely to non-accelerating universes.

A **demonstration based on conformal metrics**

Given the Friedmann equations of the FLRW metric:

$$H^2 = \left(\frac{a'}{a}\right)^2 = \frac{8\pi G\rho}{3c^2} - \frac{kc^2}{a^2}$$

$$\left(\frac{a''}{a}\right) = -\frac{4\pi G}{3c^2}(\rho+3p)$$

In this FLRW metric,

$$ds^2 = dt^2 - a(t)^2(g_{\mu\nu}\, dx^\mu dx^\nu)$$

the non-accelerating universes are solely those that satisfy $a(t)'' = 0$.

Let the FLRW metric be in coordinates (t, x_1, x_2, x_3) where "t" is the commoving time and x^i are the spatial coordinates, (c=1).

$$ds^2 = dt^2 - a(t)^2(g_{\mu\nu}\, dx^\mu dx^\nu)$$

We are looking for a coordinate transformation that will convert this metric into a conformal metric. We make the following coordinate change:

$$dt = d\tau.\ a(\tau)$$

$$a = a\ (t(\tau))$$

$$a(\tau) = dt/d\tau$$

The conforming metric will be:

$$ds^2 = a(\tau)^2(d\tau^2 - g_{\mu\nu}\, dx^\mu dx^\nu)$$

where the scale factor $a(\tau) = a(t(\tau))$ is now a function of conformal time. Conformal time is not the proper time of any particular observer, but these coordinates have some advantages.

A metric is locally conformally flat if, at every point, there exists an open neighborhood where the metric can be represented by a conformally equivalent flat metric—flat in the usual sense that the curvature tensor vanishes. This means that, within an open neighborhood of each point, the metric can be represented by a flat metric.

According to the work of (Masao I et al. 2007), FLRW metrics are locally conformally flat metrics

Furthermore, we can relate $a'(t)$ to $a(\tau)$ and $a'(\tau)$ as follows

$$a(\tau)' = da(\tau)/d\tau =$$

$$= (da(t(\tau))\ /dt).\ (dt/d\tau) =$$

$$= a(t)'.\ a(\tau);$$

$$a(t)' = a(\tau)'/a(\tau)$$

Given this FLRW metric, the $R_{\tau\tau}$ term of the Ricci tensor for the corresponding conformal metric is expressed as follows (Janssen, B., 2013):

$$R_{rr} = 3((a(\tau)''/a(\tau)) - (a(\tau)'/a(\tau))^2)$$

Since the FLRW metric is a locally conformally flat metric, the following holds: at every point, there exists an open neighborhood containing a conformally flat metric with zero curvature tensors. Thus:

$$0 = R_{rr} = 3((a(\tau)''/a(\tau)) - (a(\tau)'/a(\tau))^2)$$

We show below that: $a''(t) \sim R_{\tau\tau} = 0$;

$$a(t)'' = d(a(t)')\ /dt =$$

$$= d(a(\tau)'/a(\tau))\ /dt =$$

$$= (d\ (a(\tau)'/a(\tau))\ /d\tau).\ (d\tau/dt) =$$

$$= ((a(\tau)''/a(\tau) - (a(\tau)')\ /a(\tau)^2)\ /(1/a(\tau)) =$$

$$= R_{\tau\tau}\,/(3a(\tau)) = 0$$

Thus, we have shown that for universes in the FLRW metric it is true that:

$$a'' = 0$$

Therefore, we conclude that the only valid solutions to the Friedmann equations are those that lead to non-accelerating universes.

3. -Conclusions

We analyze the solutions to the Friedmann equations from a mathematical perspective, closely examining the FLRW metric. Drawing on the work of Masao I. et al. (2007)—which demonstrates that the FLRW metric is locally conformally flat—we investigate the required form of the scale factor "a" to ensure this topological characteristic holds true at all times. The result is that the only valid solutions are those where the second derivative of the scale factor is zero at every point; in other words, solutions that describe universes without acceleration.

Until a few months ago, this conclusion would have been rejected, as the belief in an acceleratingly expanding universe had been considered a certainty since (Riess A et al., 1998). However, a group of South Korean scientists (Junhjuk Son et al., 2025)—followed by Indian scientists (Animesh Sah et al., 2026) —re-analyzed the original data used to discover the universe's accelerated expansion and found that the previous conclusion was invalid; according to these scientists, the universe is not expanding with acceleration and may actually be contracting. U.S. scientists (Wiseman P et al., 2026). were quick to respond, defending the validity of the initial calculations regarding the universe's acceleration. We now await experimental results from the Nancy Grace Roman Telescope—which became operational just a few weeks ago—to determine the true nature of our universe's expansion. We wait and see.

Data availability:
No new data were generated or analyzed in support of this research.

Conflict of interest:
The author states that there is no conflict of interest

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