

A Logical Critique of Time Dilation in Special Relativity

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Abstract

This article presents a logical critique of the concept of time dilation within the framework of Special Relativity. Through a simple thought experiment involving three brothers and two spaceships, we highlight the logical tension between the objective age of a physical object (a person) and the observer-dependent time intervals predicted by the Lorentz transformation. The analysis raises fundamental questions regarding the nature of reality and the interpretation of relativistic effects.

1 Introduction

Time dilation is one of the cornerstone predictions of Special Relativity (SR). *According to SR, time intervals expand as a physical object (a person) moves relative to two other observers.* In this article, we present a thought experiment (gedankenexperiment) to highlight a logical inconsistency in Special Relativity.

This article examines the logical coherence of Special Relativity rather than its empirical predictions.

The magnitude of this dilation of the time interval is controlled by the Lorentz factor:

$$\gamma(v) = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (1)$$

The dilated time t' is given by:

$$t' = \gamma(v)t \quad (2)$$

where t is the proper time¹ (the time in the object's rest frame).

¹In Special Relativity, *proper time* refers to the time interval measured by a clock that is at rest relative to the object under observation—i.e., the time experienced by the object itself. *Coordinate time*, on the other hand, is the time assigned to events by an external observer using a particular inertial reference frame. The concept of *age* in the context of SR is often equated with the accumulated proper time of a

2 The Thought Experiment

Consider three brothers, B_0 , B_1 and B_2 who are triplets, they are of the same age,

$$a_0 = 20 \text{ years} \quad (3)$$

These three brothers decide to test the Special Theory of Relativity (SRT). They contact Mr. Elon Musk and his Space X and order two spaceships. Brother B_0 remains on Earth while the other two brothers B_1 and B_2 travel with their spaceships at speeds v_1 and v_2 , relative to Earth. The speeds are:

$$v_1 = 100,000 \text{ km/s} \quad (4)$$

$$v_2 = 200,000 \text{ km/s} \quad (5)$$

According to SRT, we can make calculations to estimate the age of two brothers as done within the experiments regarding the twin paradox.

We consider two simultaneous experiments:

E1: The pair (B_0, B_1)

E2: The pair (B_0, B_2)

The reader may perform this calculation if desired.

We conduct experiment E1 and determine B_0 's age at its conclusion to be a_{01} . Then we run the experiment E2 and determine B_0 's age at the conclusion of E2 to be a_{02} . It is obvious that B_0 ages at different rates in the two experiments, due to different relative speeds in each experiment.

But now we are running a third experiment when the two spacecraft launch simultaneously.

A question to all proponents of Special Relativity: how does B_0 age during this experiment?

3 Logical Analysis and Critique

The core issue presented by this thought experiment is the logical conflict between objective reality and observer-dependent phenomena. Brother B_0 exists, living his ordinary life, as a physical object with the age of 20, but **Special Relativity claims that he ages at two different rates simultaneously**.

This brings to the fore a central question: Can a single person or object possess multiple, simultaneously valid ages? If age is a property of the object itself, allowing it to change implies observing that age is not an intrinsic property but rather a relational property. This calls into question the classical notion of an objective physical reality.

A single object cannot have multiple, simultaneously valid ages in a logically consistent physical theory.

person or object. However, logical inconsistencies may arise when an object's age appears to depend on the observer's frame, as explored in this article.

4 Discussion

The interpretation of time dilation is often debated within the physics community. There are two primary points of view:

- (a) **Physical Effect:** Time dilation represents a real physical increase in the age of an object due to motion.
- (b) **Coordinate Effect:** Time dilation is just a consequence of using different coordinate systems and does not reflect any physical change.

Some proponents of Special Relativity may argue that time dilation is a coordinate effect rather than a physical property. However, this interpretation does not resolve the logical contradiction highlighted in the thought experiment, as it leaves the objective physical properties of the object ambiguous.

In both cases, the logical tension remains: the brother either physically changes age depending on who observes it, or the concept of "age" (time) becomes entirely dependent on the choice of coordinate system, making the objective physical properties of the brother ambiguous.

This article's thought experiment highlights that Special Relativity's handling of age (time) violates the logical identity principle – a single object should have a single age (time) at any given time.

5 Conclusion

This simple example illustrates that Special Relativity's time dilation leads to a logical contradiction when interpreted as a physical property of objects. Either age (time) ceases to be a fundamental property of physical reality, or the theory requires reconsideration to reconcile these contradictions.

The analysis presented here complements previous critiques of Special Relativity, including the author's prior works [1, 2, 3, 4], and invites further discussion on the logical foundations of modern physics.

Future research could explore alternative formulations of space and time that avoid such contradictions, possibly by re-examining the foundational assumptions of Special Relativity.

References

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- [4] *A Logical Critique of Length Contraction in Special Relativity*; Jan Slowak; 2025; ResearchGate; DOI: 10.13140/RG.2.2.34686.29765