A Logical Examination of Length Contraction
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Abstract
I. As defined by Special Relativity, the only distinction between time dilation and length contraction is that time delay applies to motion along all three axes of movement whereas length contraction only applies motion along the direction of the movement of the object.
II. Our understanding of science has changed substantially since Special Relativity was published in 1905 and the present. The most important changes were:
   a. Physical time came into being when the big bang occurred.
   b. The characteristics of physical time are not the same as the characteristics of observed time.
   c. The Rossi-Hall experiment proved that time dilation was a characteristic of physical time, not of observed time.
III. The existence of length contraction has not been proven by experiment.
IV. No logical procedure for testing the concept of length contraction has been suggested.
V. Objects which are subjected to time dilation are treated differently than those subjected to length contraction.
VI. Items subjected to length contraction may be changed physically in unpredictable ways—how does one contract the length of water?
VII. Application of Ockham’s razor suggests that length contraction does not exist.

Key Words
Physical time, Big Bang, Rossi-Hall, Hafele-Keating.

Introduction
Albert Einstein’s “On the Electrodynamics of Moving Bodies”¹, which he wrote in 1905, originated both the concept of time dilation and of length contraction. The only obvious distinction he draws between them is that time dilation applies to motions along all three axes of movement while length contraction applies only to motions along the direction of movement of the object. This distinction will be discussed below in more detail.

As was shown in my article “The Nature of Time – A 21st Century View”², the advances that were made to our understanding of the nature of time in the 20th century made it evident that changes to our understanding of Special Relativity, which were discussed in the article, are essential if Special Relativity is to be consistent with current scientific understanding of the nature of the universe.

The three most important of these discoveries were:
• Physical time came into being when the big bang occurred.
• The characteristics of physical time are not the same as the characteristics of observed time.
• The Rossi-Hall experiment³ which proved that time dilation was a characteristic of physical time, not of observed time.

According to “Physics For Engineers and Scientists”⁴ the existence of length contraction has not been proven by experiment. The reason for this is not given, but it is probably because conducting such an experiment would be physically difficult, if not impossible. For that reason this discussion will be based on logic, not on physical experimentation.

Grounds for questioning the existence of Length Contraction
A. Length contraction was postulated by George FitzGerald (1889) and Hendrik Antoon Lorentz (1892) to explain the negative outcome of the Michelson–Morley experiment. Special Relativity, which was proposed by Albert Einstein in 1905, incorporated both the concept of time dilation and the concept of length contraction; thus eliminating the apparent need for a separate proof of length contraction.
B. Although Special Relativity incorporated the concept of length contraction, no logical procedure for testing its existence has been suggested.

a. The suggestion by “Physics for Engineers and Scientists” that the length of the rod on the space ship can be compared with the length of the identical rod on earth is not useful because on the space ship the observers do not observe any change in the length of the rod and any communication of their observation to earth would only reflect what the observers observed; they would have no way of comparing their observation with the uncontracted length.

b. Saving the rod from the space ship for comparison purposes on earth is pointless because when the spaceship returns to earth the spaceship rod has reverted to its original length.

C. When an object which has been subject to time dilation is returned to Earth, where there is no time dilation, the clocks which measured the elapsed time retain the reduction to the amount of time they had experienced.

When an object that has experienced length contraction returns to earth, the object returns to its original length without retaining any evidence that its length had ever been contracted.

D. No explanation has been given regarding how an object would be able to return to its previous state since it has not been explained how time could go into reverse. On the other hand if the object’s length did not return to its previous state, the results could be very strange, particularly if the length contraction had been applied to an observer.

E. If the object subject to length contraction had been a ball bearing it might be transformed from a spherical object to an ellipsoidal one — ellipsoidal bearings don’t function very well.

F. The Hafele-Keating experiment proved that airplanes experience time dilation, therefore, if length contraction exists, the airplanes must experience it every time they make a flight. This length contraction must be very small, but since it is repeated so many times it would seem as if its parts could be distorted.

The fact that there have been no reports of resulting malfunction suggests that there was no length contraction.

G. Einstein wrote his paper about Special Relativity in 1905. Between 1905 and the present there have been many, many changes to our knowledge of particle physics, about which Einstein could not have known about. I am not a particle physicist so I don’t really know what I am talking about, but I assume that most atoms are symmetric in structure and that the physical spacing within the atom is critical.

If we had some particles which were subject to a significant amount of length contraction applied along a single axis it would seem to me that changing the spacing of the particles inside an atom would have some unexpected results; for example, supposing the atoms were atoms of U235; could there be some unpleasant effects?

H. Assume a very long train travelling across Kansas at a very high rate of speed with synchronized caesium clocks scattered throughout the train at locations such as the wheels and the axles, individual seats, electrical wiring, bathroom facilities including the water. The whole train would be subject to time dilation, so all of the clocks on the train would be subject to time dilation.

I. Assume for the sake of argument that the entire train was subject to length contraction so the length of the train would be reduced. Explanations of length reduction do not specify whether the length reduction is made at the front of the train, the end of the train or at both ends. Assume that it is made at both ends.
a. As the train travelled down the track, since length contraction would make it shorter than its original length, it wouldn’t take as long to travel a specified distance as it would if were not subjected to length contraction, so its time dilation is less.

b. The clocks were at a variety of locations so identifying which ones were subject to length contraction would not be simple — how does one contract the length of water?

c. Which of the clocks would retain their original time delayed reading of the clock and which ones would be changed? And by how much?

J. As one can see from the above, the concept of length contraction is not a simple one. At this point I think it would be appropriate to call in Ockham’s razor. Does length contraction exist or does it not? Deciding that length contraction doesn’t exist requires a single assumption, since there has never been any experimental proof of its existence, but look at all the complications that arise if it does exist.

K. I have reached the conclusion that until someone can devise an experiment that proves the existence of length contraction and can resolve the problems identified above, length contraction does not exist!

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3 Rossi, B., Hall, D.B. (1941) *Variation of the Rate of Decay of Mesotrons with Momentum*. Physical Review 59 (3) 223-228