

Why mass doesn't increase with velocity

David M. Bower / email: wpd.hbt777@gmail.com

12 MAR 2026

1 Abstract

Ever since the advent of special relativity over one hundred years ago, there has been considerable debate over the concept of "relativistic mass", i.e., whether mass increases with velocity. Although the equations of Einstein's version of special relativity (ESR) can be interpreted to show that mass increases with velocity (and that such an increase of mass with velocity seems logically required to explain that light speed is a limiting velocity), assuming that mass increases with velocity is associated with an insurmountable logical contradiction (in view of a previously published paradox involving ESR). This insurmountable contradiction suggests that it is meaningless to postulate that mass increases with velocity.

2 Introduction

There are at least two versions of special relativity – one due to Einstein (denoted with the acronym "ESR"), and one being the work primarily of Lorentz (with input from Poincaré). The version of special relativity due to Einstein (i.e., ESR) has become universally accepted. However, ESR is plagued by paradoxes and conflicting interpretations.

Some of the paradoxes involving ESR include the twin paradox, the Ehrenfest (rotating disc) paradox and Bell's spaceship paradox (first published by E. Dewan and M. Beran in 1959). A relatively new paradox was published in [2]. An implication of this paradox – that the twin paradox is incapable of being resolved or explained¹ – was first published in [3]. The main reason that ESR is plagued by paradoxes is because it is built upon Newtonian mechanics. Newtonian mechanics is built on (or rather, incorporates) circular reasoning because it does not specify a "prototype" (or "boilerplate" or "primordial") inertial reference frame from which all other inertial reference frames can be derived by Galilean boosts².

Some of the conflicting interpretations of ESR involve ideas such as the concept of simultaneity as it relates to causality and the concept of relativistic mass with its hypothesis that mass increases

¹Although the analysis in that paper was based on a boost having a scaled velocity β of 0.75, the analysis can almost without thought be extended to any other value of β .

²Newtonian mechanics may consider "absolute space" to be the basis for the prototype inertial reference frame, but it gives not operational procedure for defining the prototype inertial reference frame.

with velocity. Some of the debate about relativistic mass is summarized in [1]. However, a second implication³ of the (relatively) new paradox of [2] is that mass cannot increase with velocity. This implication is explained as follows.

Consider an isolated material object O in outer space far from any gravitational influence. Let the inertial rest mass of the object O be denoted m_i . Now consider an inertial reference frame S moving with constant velocity v with respect to the object. According to some interpretations of ESR, its relativistic mass m_r is given by

$$m_r = \frac{m_i}{\sqrt{1 - \beta^2}} \quad (1)$$

where $\beta = v/c$ and the symbol c represents the speed of light.

The paradox resulting from assuming that relativistic mass varies as shown by (1) is that a plethora of different inertial reference frames all moving with different velocities can be imagined. Labeling these different inertial reference frames and their relative velocities with integer subscripts we have reference frame S_1 moving with relative velocity v_1 , frame S_2 moving with velocity v_2 , reference frame S_3 moving with velocity v_3 , etc. Scaling all of these velocities by dividing by lightspeed c we have the following absurdity:

$$\begin{aligned} m_{r,1} &= \frac{m_i}{\sqrt{1 - \beta_1^2}} \\ m_{r,2} &= \frac{m_i}{\sqrt{1 - \beta_2^2}} \\ m_{r,3} &= \frac{m_i}{\sqrt{1 - \beta_3^2}} \\ &\dots \\ m_{r,n} &= \frac{m_i}{\sqrt{1 - \beta_n^2}} \end{aligned} \quad (2)$$

and

$$m_{r,1} \neq m_{r,2} \neq m_{r,3} \neq \dots \neq m_{r,n} . \quad (3)$$

Equation(3) expresses the contradictory conclusion from assigning a relativistic mass to the object O according to (1). It is impossible to have a well- defined value of relativistic mass if an infinite number of values can be simultaneously assigned to relativistic mass.

Also, since increase of mass with velocity can no longer be invoked to explain why light speed is a limiting speed, another explanation for light speed as a limiting speed must be found.

³That is, an implication in addition to the implication that the twin paradox cannot be resolved

References

- [1] Carl G. Adler. “Does mass really depend on velocity, dad?” In: *American Journal of Physics* 55 (1987), p. 739. URL: doi.org/10.1119/1.15314 (visited on 03/12/2026).
- [2] David M. Bower. “A new paradox involving the Lorentz transformation”. In: *viXra* (2024). DOI: <https://arxiv.org/pdf/2401.0070v1.pdf>.
- [3] David M. Bower. “The Paradox of the Quintuplets: Why the Twin Paradox of Special Relativity Cannot be Resolved”. In: *viXra* (2024). DOI: <https://vixra.org/pdf/2406.0003v2.pdf>.