International Journal of Advanced Engineering and Management Research

Vol. 10, No. 05; 2025

ISSN: 2456-3676

The Incorrect Lorentz Transform Leads to the Formula $E = mc^2$ Being Wrong

[1]LE THANH DUC, LE THI THU THUY[2].
[1]University of Transport Ho Chi Minh City,
Ho Chi Minh, Vietnam
[2]Campus in Ho Chi Minh City, University of Transport and Communications, Ho Chi Minh City, Vietnam

doi.org/10.51505/ijaemr.2025.1416 URL: http://dx.doi.org/10.51505/ijaemr.2025.1416

Received: Oct 01, 2025 Accepted: Oct 21, 2025 Online Published: Oct 28, 2025

Abstract
Albert Einstein is a great physicist. He gave the formula that describes the nature of the relationship between mass and energy. The formula $E = mc^2$ is a classic of modern physics. It has great practical applications. It has been considered correct for a long time and is applied even in the most recent studies. The purpose of this article is to demonstrate the irrationalities in the process of constructing this formula. The author gives arguments based on physical and mathematical knowledge, pointing out the mistakes of Hendrik Antoon Lorentz and Albert Einstein. Uncertain factors have been considered. Fundamental aspects have been mentioned. Although further experimental studies are needed, the incorrect arguments in the formula have been pointed out. This result will profoundly impact the current and future knowledge base, as well as other great applications in practice.

Keywords: physics, equation, Einstein's, mistakes, classical.

1. Introduction

Albert Einstein's formula $E = mc^2$ is one of the most famous equations in the history of physics, expressing the equivalence relationship between energy (E) and mass (m), where c is the speed of light in a vacuum. Although this formula is famous, proving it is not simple and requires a deep understanding of **Einstein's Special Theory of Relativity.**

The Meaning of $E = mc^2$:

The formula $E = mc^2$ is not only a mathematical equation but also a revolutionary discovery:

- Equivalence between mass and energy: It proves that mass and energy are not two separate entities but can be converted into each other. Mass can be considered a form of "frozen" energy, and conversely, energy can "create" mass.
- Explanation of nuclear phenomena: This is the basis for explaining the enormous energy

released in nuclear reactions (nuclear fission and fusion), such as in atomic bombs or solar energy. A small amount of mass "lost" in the reaction will be converted into energy.

- Foundation of modern physics: This formula is one of the pillars of modern physics and has completely changed how we understand the universe, from the structure of matter to the evolution of stars.

Until recently, this formula has continued to be the basis for much modern research in physics and technology.

Here are some highlights from recent articles and analysis:

- Nuclear physics and renewable energy: This formula remains the basis for understanding nuclear fission and fusion – for example, in nuclear reactors or research on fusion energy, which is being developed as a clean energy source.
- Nuclear medicine: In PET (positron emission tomography) technology, converting mass into energy helps create detailed images inside the body, supporting diagnosing cancer and neurological diseases.
- Cosmology and quantum physics: Scientists are using the principle from the formula $E = mc^2$ to study dark energy, dark matter, and phenomena such as black holes, where mass can be converted into huge amounts of energy.
- Analyzing the universe's structure: Some recent research has focused on using this formula to simulate galaxies' formation and the universe's expansion, primarily in Big Bang models.

Here is a common approach to deriving the Lorentz factor, usually done by considering **time dilation:**

The **Lorentz factor**, $\gamma = \dfrac{1}{\sqrt{1 - \dfrac{v^2}{c^2}}}$, is a dimensionless quantity that occurs naturally in the equations of Special Relativity. It describes how measurements of time, length, and other physical properties change when an object moves at a relatively high velocity. The formulation (or derivation) of the Lorentz factor follows directly from Einstein's two postulates of Special Relativity:

1. **The principle of relativity:** The laws of physics are the same in all inertial frames of reference.
2. **The constancy of the speed of light:** The speed of light in a vacuum (c) is the same for all observers, regardless of the relative motion of the light source or the observer.

Imagine a simple "light clock" consisting of two parallel mirrors separated by a distance L_0 . A photon of light bounces back and forth between these two mirrors. Each time the photon hits a mirror, it's considered a "tick" of the clock.

Case 1: The clock is at rest in reference frame S_0 (proper frame)

In the reference frame S_0 where the clock is at rest, the photon travels a distance L_0 to go from one mirror to the other.

Vol. 10, No. 05; 2025

ISSN: 2456-3676

The time for the photon to travel one way is $\Delta t_0 = \frac{L_0}{c}$

So, the time for one "tick" (photon going forth and back) is $2\Delta t_0 = \frac{2L_0}{c}$

Case 2: The clock is moving in reference frame S

Now, let's consider this clock moving at a velocity v parallel to the mirror surfaces (i.e., perpendicular to the photon's path) relative to an observer in reference frame S.

- From the perspective of the observer in frame S:
- The photon must still travel diagonally to get from one mirror to the other, because the mirrors are moving sideways.
- The total distance the photon travels during one "tick" (going from one mirror to the other and back) will be longer than $2L_0$.

Let's look at half a "tick" (the photon going from the bottom mirror to the top mirror). During this time, the photon travels a distance $c\Delta t$, and the clock itself moves a distance. $v\Delta t$

We can visualize a right-angled triangle with:

- The hypotenuse being the distance the photon travels: $c\Delta t$
- One leg being the vertical distance between the mirrors: L_0
- The other leg being the distance the clock moves horizontally: $v\Delta t$. $v\Delta t$ (more precisely, $v\frac{\Delta t}{2}$ to reach the midpoint of the horizontal path, and then another $v\frac{\Delta t}{2}$ to reach the end point).

Applying the Pythagorean theorem for one half of the light's journey (let Δt be the time for the light to travel from one mirror to the other in frame S):

$$(c\Delta t)^2 = L_0^2 + (v\Delta t)^2 \qquad (1)$$

Rearrange the equation:

$$c^2(\Delta t)^2 = L_0^2 + v^2(\Delta t)^2 \qquad (2)$$

$$c^2(\Delta t)^2 - v^2(\Delta t)^2 = L_0^2 \qquad (3)$$

$$(\Delta t)^2(c^2 - v^2) = L_0^2 \qquad (4)$$

$$(\Delta t)^2 = \frac{L_0^2}{c^2 - v^2} \qquad (5)$$

$$(\Delta t)^2 = \frac{L_0^2}{c^2\left(1 - \frac{v^2}{c^2}\right)} \qquad (6)$$

$$\Delta t = \frac{L_0}{c\sqrt{1-\frac{v^2}{c^2}}} \qquad (7)$$

We know that $\Delta t_0 = \frac{L_0}{c}$ is the proper time (when the clock is at rest). Substituting this into the equation above:

$$\Delta t = \frac{\Delta t_0}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (8)$$

And this is exactly where the Lorentz factor appears.

$$\Delta t = \gamma \Delta t_0 \qquad (9)$$

Where:

$$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (10)$$

Significance of the Lorentz Factor:

When v=0: $\gamma = \frac{1}{1-0} = 1$. This means that when there is no relative motion, time passes the same for both observers, and there are no relativistic effects.

When v→c (velocity approaches the speed of light): The denominator $\sqrt{1-\frac{v^2}{c^2}}$ approaches 0, and γ approaches infinity (∞) . This leads to infinite time dilation $(\Delta t \to \infty)$ and infinite length contraction (L′→0), indicating that objects with mass cannot reach the speed of light.

Value is always greater than or equal to 1: $\gamma \geq 1$.

The Lorentz factor is a crucial element in all Lorentz transformations and other relativistic formulas, including $E = mc^2$ (where the total energy of a moving object is $E = \gamma mc^2$. It directly illustrates the fundamental difference between classical (Newtonian) physics and relativistic (Einsteinian) physics when dealing with high velocities.

2. Method

In the above thought experiment, Lorentz used two mirrors, one fixed and one movable. To make it easier to visualize, let us consider Lorentz as examining a moving object relative to a stationary object. The moving object represents the mirror that is translating, and the stationary object represents the fixed mirror. The faster the object moves, the slower time passes. The Lorentz coefficient was wrong at one point when it was established. Lorentz considered the passage of time within the framework of translational motion (this is a special case of motion in 3D space). In the general case, the two mirrors are parallel to each other, and the photon of light

Vol. 10, No. 05; 2025

ISSN: 2456-3676

moves, but the Pythagorean theorem cannot always be applied to calculations. Let us consider a few specific images below:

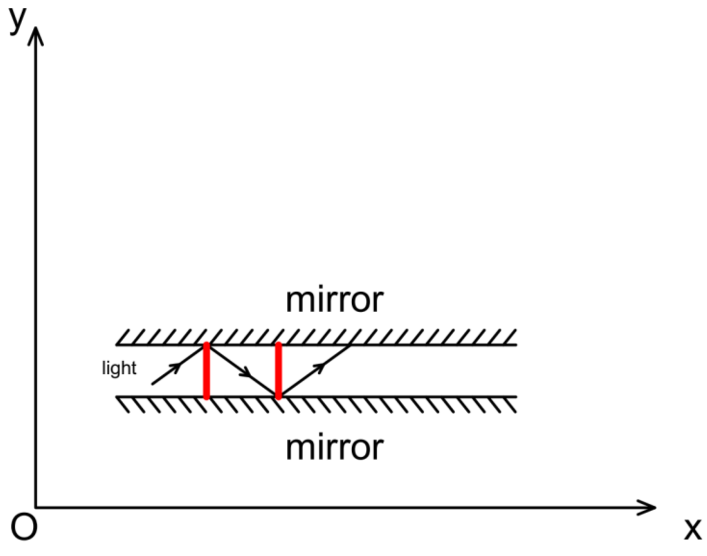

Figure 1. The image shows the S-frame of reference. This is where light is seen as traveling between two parallel plane mirrors. The object moves forward. Light moves in mirror (non-curved)

When the mirror moves in translation (or in other words, the object moves in translation in the x direction), we can use this diagram (Lorentz's diagram) to calculate. The red lines are the lines involved in calculating the Pythagorean theorem. The black lines (with arrows) are the paths of the light rays.

Vol. 10, No. 05; 2025
ISSN: 2456-3676

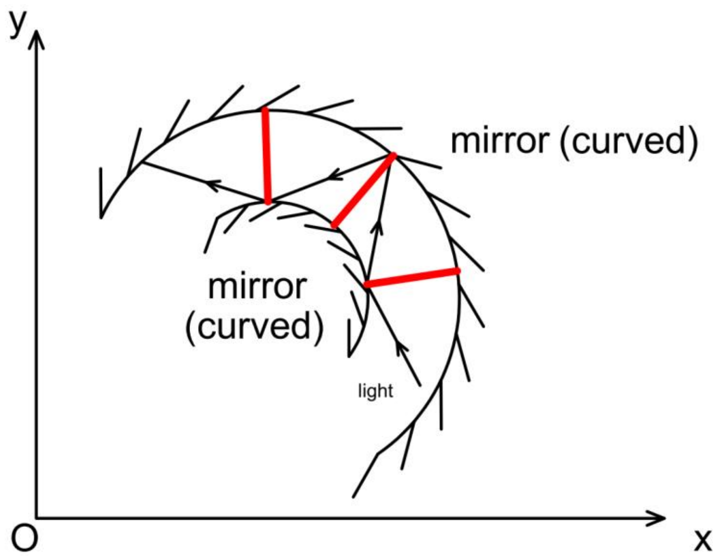

Figure 2. The image depicts a reference frame. Where light travels in reality (Two mirrors are not flat). The object moves without translation. Light moves in mirror (curved)

When light moves in a curved mirror (or, in other words, the object moves along a curve in 3D space), the red lines do not form a right triangle, so it is impossible to calculate based on the Pythagorean theorem. Thus, in this case, the Lorentz coefficient cannot be calculated. From that, it can be inferred that the formula $E = \gamma mc^2$ is generally wrong. So all the consequences arising from this formula are also wrong.

Albert Einstein's principle applies to inertial reference frames, that is, only for straight and uniform motion or at rest. However, there is no such motion in the universe due to the influence of gravitational, electromagnetic, and environmental forces. The article proposes an example as follows:

Let us recall the Lorentz transformation:

The Lorentz transformation is a transformation of spatial and temporal coordinates so that they satisfy Einstein's two postulates. Lorentz proposed the following coordinate system:

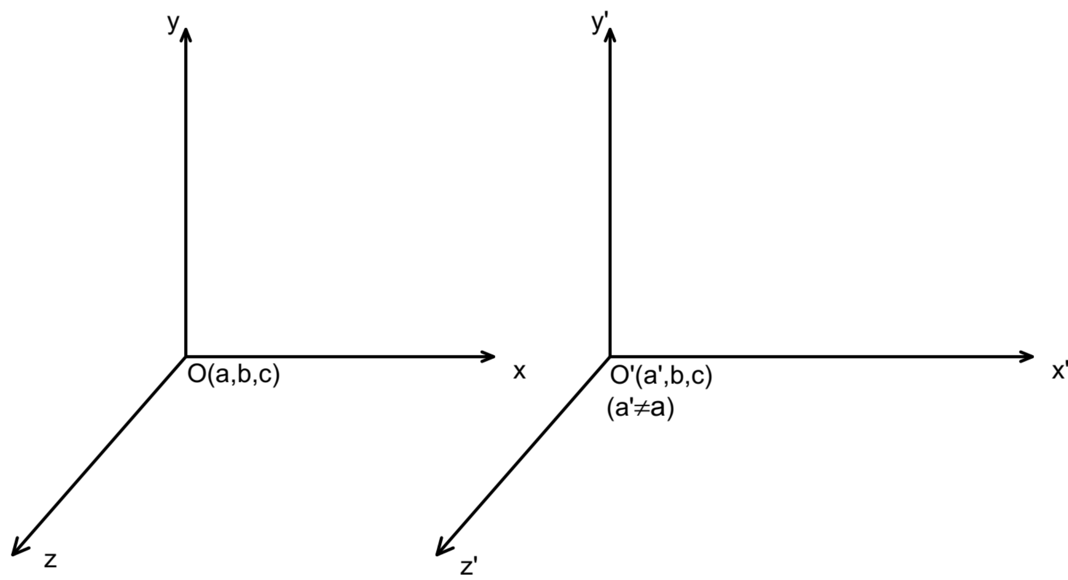

Figure 3. Coordinate system proposed by Lorentz (a, b, c: coordinates of point O; a', b, c: coordinates of point O')

Lorentz argues that O and O' are two inertial reference frames. O' moves in a straight line with O at a velocity v so that O'x' slides along Ox. Then, the spatial coordinates: y' = y, z' = z. Based on this argument, Lorentz constructed the gamma coefficient, which we have known above.

There is a fundamental mistake in the above argument, which is: O and O are two inertial reference frames. However, O does not necessarily have to slide along Ox to preserve the properties of the inertial reference frame. In the most general case. O' (x', y',z') with $x' \neq x; y' \neq y; z' \neq z$*. In this general case, O still satisfies Einstein's two postulates (that is, O' is an inertial reference frame). We described this coordinate system in the following figure:*

Vol. 10, No. 05; 2025

ISSN: 2456-3676

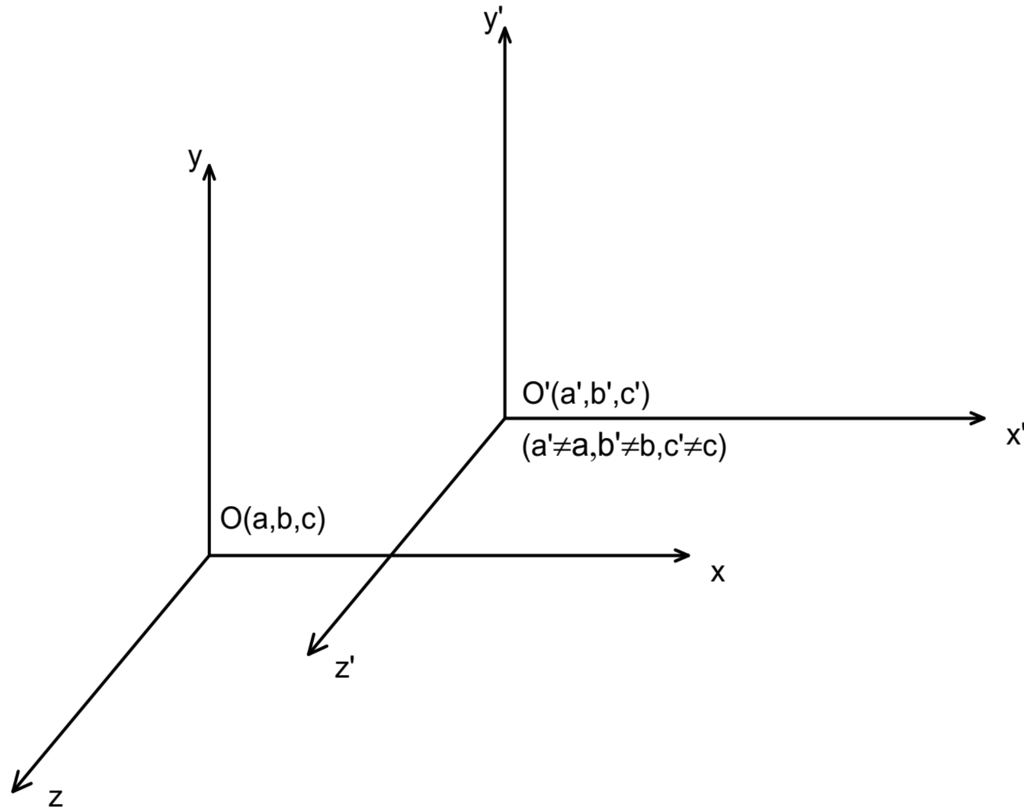

Figure 4. Coordinate system proposed by the article (a, b, c: coordinates of point O; a', b', c': coordinates of point O')

In our 3-dimensional physical space, the coordinate system satisfies a very general property. Lorentz's argument is a special case. Therefore, Lorentz's calculation is wrong.

Time passes faster for satellites in Earth orbit due to the effect of relativity. Specifically, according to the special theory of relativity, fast motion makes time pass more slowly. However, according to the general theory of relativity, the weaker gravitational force at high altitudes makes time pass more quickly.

For GPS satellites, the atomic clocks on them record that time passes about 45.7 microseconds per day faster than clocks on the ground.

This is a classic figure written and calculated in physics textbooks. Whether on Earth or in space. The satellite's orbit is a curve. This is an accelerated motion, so it is basically not an inertial reference frame. However, data from atomic clocks still record the above results.

ISSN: 2456-3676

For light, in essence, light travels straight, but due to gravity's influence, light follows a curved path when passing through space. Thus, the Lorentz coefficient cannot be calculated.

In addition to the above issues, the refractive index of the medium is also an important factor. We know that: $n = \frac{c}{v}$

In which: n – is the refractive index of the medium, v – the speed of light in that medium, c – is the speed of light in a vacuum

Although our air is skinny, the refractive index n>1 is certain, so v<c. In that particular environment, Albert Einstein did not consider this factor. Moreover, this is another mistake in the formula $E = mc^2$. In air, the refractive index n varies according to the density of the air. We also see that the humidity of the air is also an important influence. Therefore, the path of the light ray is also very complicated. The Lorentz coefficient is also very difficult to determine.

3. Results

We analysed this study's model and mathematical methods and obtained some important results. Specifically, we have proved that the central equation $E = mc^2$ is wrong through mathematical and physical arguments. These arguments show that the general case's relationship between mass and energy is not correct. In addition, we have shown that constructing a correct formula for representing the mass and energy relationship is very complicated. The correct formula will include many variables and constraints on specific physical conditions. Therefore, this correct formula will provide more insight into its application and potential in the future.

4. Discussion

The article points out the mistakes of Albert Einstein when constructing the formula $E = mc^2$. Although in the general case this is an incorrect formula, some of its basic meanings are still valuable. Because the formula is still correct in the specific case of translational motion, it is still valuable in explaining nuclear phenomena and the relationship between mass and energy. In addition to these values, the results of proving the formula will profoundly affect the foundations of modern physics. This article still needs further research to determine the correct formula for the relationship between energy and mass.

5. Conclusion

This article has added to our understanding of the field of physics, refuted the correctness of one of the classic physics formulas, and brought practical values to society. Finally, the author hopes the proven correctness will continue as the premise for further research.

ISSN: 2456-3676

References

Benjamin Crowell. (2022). *General Relativity*.

Daniel Brett, Joseph Vovrosh. (2015). *Maths for Physics*, University of Birmingham – Mathematics Support Centre.

David J. Raymond. (1999 ebook). *Introduction to Continuum Mechanics.*

David Tong. (2013). *Dynamics and Relativity*, http://www.damtp.cam.ac.uk/user/tong/ relativity. htmlrevtex

Dirac, P.A.M. (1975). *General Theory of Relativity*. JOHN WILEY – SONS, USA.

Dr Eric Ayars. (2013). *Computational Physics With Python.*

Jagdish Mehra. *Einstein, Physics and Reality*, World Scientific, USA.

Jiˇr´ı Biˇc´ak, Oldˇrich Semer´ak. (2025). *Relativistic physics (lecture notes).*

Julio Gea-Banacloche. (2019). *University Physics I: Classical Mechanics*, ScholarWorks@UARK,

Max Born. (1927). *Einstein's theory of Relativity.* E.P. Dutton and Company Pulishers

Max Planck. (1915). *Eight Lectures on Theoretical Physics.* Columbia University Press, USA.

Ondˇrej ˇCert´ık. (2023). *Theoretical Physics Reference.*

Robert W. Lawson. (2002). *Relativity: The Special and General Theory*. Taylor and Francis e-Library

Stephen Sekula. *Modern Physics, Southern Methodist University*, Dallas, TX, USA

Timon Idema. *Mechanics and Relativity*. http://textbooks.open.tudelft.nl

Uttarakhand Open University. (2019). *Modern Physics.*