Reductio ad Absurdum
Modern Physics' Incomplete Absurd Relativistic Mass Interpretation
And the Simple Solution that Saves Einstein's Formula.

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January 11, 2018

Abstract

This note discusses an absurdity that is rooted in the modern physics interpretation of Einstein's relativistic mass formula when v is very close to c. Modern physics (and Einstein himself) claimed that the speed of a mass can never reach the speed of light. Yet at the same time they claim that it can approach the speed of light without any upper limit on how close it could get to that special speed. As we will see, this leads to some absurd predictions. If we assert that a material system cannot reach the speed of light, an important question is then, "How close can it get to the speed of light?" Is there a clear-cut boundary on the exact speed limit for an electron, as an example? Or must we settle for a mere approximation?

Key words: Relativistic mass, maximum velocity of subatomic particles, boundary condition, Haug maximum velocity.

1 Introduction

Einstein's relativistic energy mass formula [1, 2] is given by

$$\frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}. \tag{1}$$

Further, Einstein commented on his own formula

> *This expression approaches infinity as the velocity v approaches the velocity of light c. The velocity must therefore always remain less than c, however great may be the energies used to produce the acceleration*[1]

Carmichael (1913) [3] came up with a similar statement in relation to Einstein's theory:

> *The velocity of light is a maximum which the velocity of a material system may approach but never reach.*

We certainly agree with Einstein's formula.[2] Our question is, "How close can v be to c?" Modern physics says nothing about this, except that it can approach c, but never reach c. Does this mean that one can make it as close to c as one wants? This is what we will look into here, and we will show that without a more specific boundary condition on v this can lead to truly absurd predictions.

Einstein's relativistic mass equation predicts that a mass will keep increasing as the velocity of the mass approaches the velocity of the speed of light. If $v = c$, then the mass would become infinite. Einstein and others have given an ad hoc solution to the problem, namely in claiming that indeed the relativistic

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[1] This quote is taken from page 53 in the 1931 edition of Einstein's book *Relativity: The Special and General Theory.* English translation version of Einstein's book by Robert W. Lawson.

[2] As a matter of fact, I have proven that Einstein's formula is consistent with atomism, a belief system that I have reason to believe contains the ultimate depth of reality.

mass never can become infinite, as this would require an infinite amount of energy for the acceleration. Still, they also seem to claim that the speed of subatomic particles can get as close to c as one would want.

The discussion above is also fully relevant at today's university campus. For example in the excellent text book "University Physics" by Young and Freedman (2016)[3] states that

> *When the particle's speed v is much less than c, this is approximately equal to the Newtonian expression...**In fact as*** v ***approaches*** c***, the momentum approaches infinity.***

Here I have marked part of the sentence in bold. Similarly, in another well-known and excellent university text book by Walker [5] we can read[4]

> *As* v *approaches the speed of light, the relativistic momentum becomes significantly larger than the classical momentum,* ***eventually diverging to infinity as*** $v \to c$.

Similar in the university physics text book by Cutnell and Johnson [6] we can read[5]

> *As* v *approaches the speed of light c, the* $\sqrt{1 - v^2/c^2}$ *term in the denominator approaches zero.* ***Hence, the kinetic energy becomes infinitely large****. However, the work-energy theorem tells us that an infinite amount of work would have to be done to give the object an infinite kinetic energy. Since an infinite amount of work is not available, we are left with the conclusion that the objects with mass cannot attain the speed of light c.*

I do not directly disagree; mathematically this is correct. My point is that modern physics does not give an exact limit on how close v can get to c, and we will soon see how this leads to absurd relativistic masses and kinetic energies. In the otherwise excellent book on special relativity by Sartori [7] we can read[6]

> *According to equation (7.12), the kinetic energy of a body approaches infinity when its speed approaches c. This important prediction is confirmed by the experimental data.*

I will claim that these statements are partly wrong, or at least they are not precise. No experiment has shown that the kinetic energy approaches infinity. What has been shown is that the kinetic energy increases rapidly as a particle is accelerated towards a velocity significantly close to the speed of light.

In 1965, Max Born [8] stated that[7]

> *A glance at formula (78)*[8] *for the mass tells us that the values of the relativistic mass* m *become greater as the velocity* v *of the moving body approaches the speed of light. For* $v = c$ *the mass becomes infinitely great. From this it follows that it is impossible to make a body move with a velocity greater than that of light by applying forces: Its inertial resistance grows to an infinite extent and prevents the velocity of light from being reached.*

Actually long ago, in 1893 Thomson [9] wrote[9]

> *When in the limit* $v = c$ *the increase in mass is infinite, thus the charged sphere moving with velocity of light* ***behaves as if its mass were infinite...***

Naturally, Thomson did not know about Einstein's theory of special relativity, as it was published 12 years later. Still his equations pointed to a similar result concerning mass when v approaches c. For further exploration, see a list of references stating similar perspectives in the Appendix.

2 The Absurdity of the Electron Following Modern Physics' Incomplete Relativistic Mass Interpretation

An electron is a very small so-called fundamental particle with a rest-mass of approximately $m_e \approx 9.10938 \times 10^{-31}$ kg. Next let's look at the relativistic mass of the electron as v approaches, but never reaches, the speed of light.

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[3] 14th edition page 1238, for full reference see [4].
[4] Fourth edition, page 1026.
[5] Ninth edition page 884.
[6] Page 209.
[7] Page 277.
[8] Born is here referring to the Einstein relativistic mass formula.
[9] Page 21. Actually Thomson used V as symbol for the speed of light and w for the velocity of the object, we have replaced these with c and v in the citation to make it easier to follow.

Absurd One Kg Mass Electron

Assume an electron is accelerated (by a giant exploding star, or by the core of a galaxy, for example) to the following velocity

$$v = c \times 0.9999999999999999999999999999999999999999999999999999999999999999999999586$$

That is 70 nines behind the decimal point followed by the number 586, or we could say it is 586×10^{-73} with nines instead of zeros after the decimal point. It gives a relativistic mass for a single electron of approximately 1 kg.

Absurd Moon Mass Electron

Assume an electron is accelerated (by for example a giant exploding star, or by the core of a galaxy) to the following velocity

$$v = c \times 0.999999999999999999999999999999999999999999999999999999999999999999999999999999999999$$
$$9999999999999999999999999999999923$$

That is 116 nines behind the decimal point followed by the number 23, or we could say it is 923×10^{-118} with nines instead of zeros after the decimal point. It gives a relativistic mass for a single electron of approximately 7.34×10^{22} kg, that is basically equal to the rest-mass of the Moon. That is quite amazing, a tiny electron that suddenly has a relativistic mass equal to the rest-mass of the moon! Where can we find such electrons?

Absurd Earth Mass Electron

Assume an electron is accelerated to the following velocity

$$v = c \times 0.99999999999999999999999999999999999999999999999999999999999999999999999999999999999$$
$$999999999999999999999999999999999999884$$

That is 119 nines behind the decimal point followed by the number 884, or we could say it is 884×10^{-122} with nines instead of zeros after the decimal point. It gives a relativistic mass for a single electron of 5.9806×10^{24} kg, that is basically equivalent to the rest-mass of the Earth.

Absurd Sun Mass Electron

Assume an electron accelerated to the following velocity

$$v = c \times 0.99999999999999999999999999999999999999999999999999999999999999999999999999999999999$$
$$99999999999999999999999999999999999999999999999895$$

That is 130 nines behind the decimal point followed by the number 895. It gives a relativistic mass for a single electron equal to the rest-mass of the Sun, that is about 1.98×10^{30} kg.

Absurd Milky Way Mass Electron

Assume an electron is accelerated to the following velocity
$$v = c \times 0.999999999999999999999999999999999999999999999999999999999999999999999999999999999999$$
$$9999999999999999999999999999999999999999999999999999999999999999999999895$$

The relativistic mass of the electron at this velocity is equal to the rest-mass of the Milky Way, that is about 10^{12} solar masses. Still, the electron is traveling below the speed of light, so this does not go against mainstream modern physics.

Insane Observable Universe Electron

Assume an electron is accelerated to the velocity of

$$v = c \times 0.9999999999999999999999999999999999999999999999999999999999999999999999999999999999999$$

9999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999996

That is 174 nines behind the decimal point followed by the number 6, or we could say it is 6×10^{-175} with nines instead of zeros after the decimal point. It gives a relativistic mass for a single electron of approximately 1.018×10^{52} kg, that is basically equal to the rest-mass of what main frame physics claims is the approximately mass of the observable universe, see [10, 11, 12, 13]. That is quite amazing, a tiny electron that suddenly has a relativistic mass equal to the rest-mass of the whole observable universe.

Modern physics leads to absurd kinetic energies for subatomic particles

The table below lists the relativistic kinetic energy of an electron traveling at various velocities, all below the speed of light. All of these velocities are valid inside the framework of modern physics, as it stipulates no precise speed limit on the velocity of an electron as long as it falls below the speed of light.

Velocity of electron % of light:	**Relativistic electron mass = rest-mass of**	**Kinetic energy:**[a]	**Ton TNT equivalent:**[b]
923×10^{-120} (9'ns in front)	Moon	6.597×10^{39} J	1.58×10^{30}
884×10^{-122} (9'ns in front)	Earth	5.375×10^{41} J	1.28×10^{32}
895×10^{-133} (9'ns in front)	Sun	1.787×10^{47} J	4.27×10^{37}
895×10^{-145} (9'ns in front)	Milky Way	1.787×10^{59} J	4.27×10^{49}

Table 1: The table shows the kinetic energy for an electron traveling at various velocities below the speed of light.

[a] The Kinetic energy is calculated as $E_k = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}} - mc^2$.

[b] One ton TNT equivalent is about 4.184 giga joules.

Why don?t we see a single electron (or other subatomic particle) with a relativistic mass equal to (even at the most moderate level) the rest-mass of the Moon? Such an electron would have enormous kinetic energy, causing a gigantic impact with collision with the Earth, or other planets in our solar system. We suspect that mainstream physics does not have a good answer to this question. Maybe such fast-traveling electrons exist, but they are rare and therefore have a very low probability of occurring? What if, as a counterpoint, a single electron wiped the dinosaurs out? Are we doomed? And why have we not heard physicists discussing such velocities for electrons? Perhaps they simply do not like to talk about such things, as they have no good explanations for why such very fast electrons have never been observed.

3 A Simple Solution to the Absurdity that Saves Einstein's Relativistic Mass Formula

Einstein's special relativity formula is perfectly correct, but it lacks an exact boundary condition on the velocity for mass. Such a boundary condition has recently been derived by Haug [14, 15, 16, 17, 18]. The maximum velocity any subatomic particle can take as measured by Einstein-Poincaré synchronized clocks[10] is given by

$$v_{max} = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}} \tag{2}$$

where $\bar{\lambda}$ is the reduced Compton wavelength of the mass in question, and l_p is the Planck length [20, 21]. When inserted into Einstein's relativistic mass equation, this show that the maximum relativistic mass that any "fundamental" particle can take actually is the Planck mass. The Planck mass is approximately 2.17651×10^{-8} kg. It is enormous compared to the electron, but still it is miniscule compared to the mass of the Moon, Earth or the Sun. Further, the Planck mass only can last for an instant, as pointed out by Haug. In other words, this seems to make perfect sense.

Further, an electron can travel at a velocity very close to that of the speed of light, but its maximum velocity will still be significantly below what is described above. The maximum velocity for an electron is

$$v_{max} = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}_e^2}} = c \times 0.99999999999999999999999999999999999999999999912416 \tag{3}$$

[10] This also holds true if measured with clocks synchronized with very slow clock transportation method, see [19].

Because there is some uncertainty in both the exact Planck length and the reduced Compton wavelength, there is some uncertainty around this velocity, but it must be very close to this number. We can rest assured that the electron (or any other mass) can never reach a relativistic mass close to even one kg, so there is no chance that a single electron will cause much harm, no matter how fast it is accelerated. This is because there is a maximum velocity that limits both its kinetic energy and its relativistic mass.

Will modern physics accept the existence of a maximum speed limit for subatomic masses based on atomism or will they keep holding on to their absurd beliefs? If they do not accept the maximum velocity for subatomic particles given by atomism, then they must accept the following absurdities:

- That there is a wavelength shorter than the Planck length. Something that is highly unlikely and impossible under atomism.
- That there is a maximum frequency higher than the Planck frequency. Something that is highly unlikely and impossible under atomism.
- That an electron can take a relativistic mass similar to that of the Moon, the Earth, the Sun, and even the Milky Way, or even larger masses. This is, at best, truly absurd! Our theory shows that no subatomic particle can take a relativistic mass higher than the Planck mass.
- That there is no limit on the relativistic Doppler shift. This is also highly unlikely. Haug [15] has shown that the limit here is the Planck frequency Doppler shift.
- For a subatomic particle, there is a momentum close to infinity. This is absurd. The maximum momentum of a subatomic particle is actually just below the Planck momentum.
- For a subatomic particle, there is a kinetic energy close to infinity. This is, again, absurd.

The newly introduced maximum velocity puts a series of limits on subatomic "fundamental particles":

- The maximum frequency is the Planck frequency: $f_{max} = 2\frac{c}{l_p}$.
- The maximum relativistic Doppler shift is equal to the Planck frequency.
- The maximum relativistic mass a subatomic particle can take is the Planck mass.
- The maximum relativistic momentum a subatomic particle can take is just below the Planck momentum.
- The maximum kinetic energy a subatomic particle can take is close to $\frac{\hbar}{l_p}c$.
- The maximum relativistic length contraction of a subatomic particle is $2l_p$, which is the length of the Planck mass.

4 Ways to Write the Maximum Velocity Formula

There are several ways to write the maximum velocity for subatomic particles that will all give the same answer; here we present some of them.

In terms of reduced Compton wavelength

$$v_{max} = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}} \tag{4}$$

In terms of particle mass

$$v_{max} = c\sqrt{1 - \frac{m^2}{m_p^2}} \tag{5}$$

where m is the rest-mass of the particle and m_p is the Planck mass.

As a function of Newton's gravitational constant

$$v_{max} = c\sqrt{1 - \frac{Gm^2}{\hbar c}} \tag{6}$$

All of these formulas are basically the same, but each one requires somewhat different input:

$$v_{max} = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}} = c\sqrt{1 - \frac{m^2}{m_p^2}} = c\sqrt{1 - \frac{Gm^2}{\hbar c}} \tag{7}$$

Electron the maximum velocity

For an electron, the maximum velocity can be written as function of the dimensionless gravitational coupling constant[11]

$$v_{max} = c\sqrt{1 - \alpha_G} \quad (8)$$

This is no surprise, since the dimensionless gravitational coupling constant is given by $\alpha_G = \frac{m_e^2}{m_p^2} = \frac{l_p^2}{\lambda_e^2}$

5 Breakdown of Lorentz Invariance at the Planck Scale?

The maximum velocity formula for anything with rest-mass would mean Lorentz invariance breaks down at the Planck scale. Based on this view, the Planck particle, the Planck length, and the Planck time, unlike any other article, length or time, seem to be the same no matter what frame they are observed from. The view that Lorentz invariance could be broken at the Planck scale appears to be consistent with what is predicted by several quantum gravity theories, see for example [26]. Lorentz symmetry is supported by a long series of tests, but it has never been tested at anything even close to the Planck scale (at distances close to the Planck length, or Planck energies) so one should be careful to use experimental evidence as an argument against this idea.

6 Conclusion

We conclude that in stating that a mass must travel more slowly than the speed of light, while at the same time asserting that it can approach the speed of light, we get absurd predictions. Examples include the idea that an electron could attain a relativistic mass equal to the rest-mass of the Moon, the Earth, the Sun, the Milky Way, or even entire galaxy clusters. Haug has recently addressed this absurdity by showing that there must be a precise maximum velocity for anything with mass given by $v_{max} = c\sqrt{1 - \frac{l_p^2}{\lambda^2}}$.

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