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Author: Omar A.H. Shabsigh

Email: omar.shabsigh@gmail.com

Deep Space Travel and a New Look at Special Relativity

Dr. Omar A. H. Shabsigh

This article discusses the upper limit imposed on the speed of traveling of any mass as being the speed of light in vacuum. The article shows, based on the results of Special Relativity, that such a limit does not exist. Speeds Beyond Speed of Light (BSOL) are possible. .

1. Introduction

By the advent of the space age in the 20th century, scientists started thinking about the existence of extraterrestrial life and travel into space. Billions of dollars were spent on such programs and is still going on.

When NASA spends all that money and time on such projects as Search for Extraterrestrial Intelligence (SETI), it means that they are expecting to detect coherent signals from outer space of other possible civilizations.

Another NASA project is its program for discovering habitable planets that are similar to earth outside the solar system (exo-planets). This of course is an indication that somebody is thinking of going there. Humans must not be bound to earth only.

Cosmos is there to be discovered and exploited, not just to look at beautiful galaxies from earth. Deep space exploration cannot be achieved by the use of today's technology of space travel.

Two factors hinder real cosmic travel, namely:

1. The limit of light speed on speed of mass put up by a misunderstanding of special relativity (SR).
2. The impossibility of communicating at speeds beyond the speed of light using electromagnetic waves.

In the present article, we shall be dealing with the first factor, i.e. speed.

Pushing physics to its limits has always been and will always be a source of advance for science in general [1], and one can actually consider that there are no limits to science unless proved otherwise.

As mentioned in [2], the exploration of the universe has enlarged further and further its size to inconceivable proportions. Given the current way in which we humans understand this exploration, that is remaining on Earth while sending round trip expeditions outside, it is

almost unavoidable not to feel that the speed of light barrier restrains our probing capacities to unbearable limits. Imagine a mission to the nearest star cluster Alpha Centauri at 4.22 light years which will take a return trip at present-day available speeds of about 10^5 km/hour; an unacceptable amount of time.

The universe is huge. By most estimates it is about 14 billion light years in expanse depending on measurements of the cosmic microwave background radiation (CMBR).

The universe is also expanding.

With the on-going search for habitable planets outside the solar system and ultimately outside our galaxy, the speed of light barrier does not really mean much, it forms some kind of fissure in the structure of the theory.

As Einstein declared, [3]: "the special relativity is a theory of principle and not a constructive theory". This should tell us a lot of what can be done to extend the special relativity. We should be open-minded in accepting an unconventional reading of the theory.

Hill and Cox [2] tried to override this apparent contradiction. However, they made a few mistakes namely: they relaxed the requirements of invariance of the energy-momentum relations. They did not say what that relaxation was. On what basis did they do that? They invented new transformations while Einstein's Lorentz transformations are quite adequate as we shall show.

Dai and Li [3] try to establish a new theory of relating without the assumption of constant speed of light. This is just a brain exercise, because the constancy of the speed of light was measured and that ends the doubt. They also state that superluminal particles should have imaginary rest mass. This is not correct, as we shall prove working within the framework of Einstein's special relativity.

The deductions of [5] about an imaginary rest mass for BSOL cases, is not correct as we shall see it. In [6] the authors try to say that the Lorentz transformations are inadequate for BSOL movement, which we shall show to be untrue. [7] tries to come up with inertial frames without relativity principle, when we should really stick with relativity. [9] tries to restrict BSOL movement to special-type theoretical cases. In contrast with [10], we shall stick with the Lorentz transformations.

Another question might come to mind. Why did Einstein choose the speed of light as the reference speed in all Lorentz transformation equations? That was because of the light postulate which was formulated and which came out from the constancy of light speed for all inertial frames. In his words: an outside observer perceives the light of the moving body".

Light is there. It could be seen by the human eye, and it could be measured. Anything beyond that would have to be guess work or measured. Any thing moving at BSOL could not and

cannot be seen.

Einstein writes about what would happen when $v=c$. But he does not elaborate for the case when $v>c$, and just says that it is impossible.

However, these restrictions should have led to thinking of BSOL movement.

This is a challenge for more research in that direction, although what will be shown in this article of the possibility of BSOL within Einstein's theory is still very much valid.

The discussion in this manuscript is about real travel of a real mass when $v>c$. A hypothetical particle like the tachyon is not relevant here. It is supposed to be a sub-atomic, hypothetical particle and we here treat bodies with real mass.

As will be seen later, no violation of causality and no break in the Lorentz invariance, are committed.

The following is based on the principle of **frames of reference**, which is exploited to the full and which is used extensively in the Special Relativity (SR) Theory.

The Special Relativity Theory (SR) is not denied. We try to understand it much better and put the basis for some change in results. We adopt the rule of Special Relativity being fully based on an **outside independent observer** looking at a moving object.

2. Facts

Here are a few facts:

Fact 1: Light travels at a constant speed of $3x10^8$ m/s in vacuum **relative to the outside observer.**

Fact 2: Relativity is true for the observer including all its parameters such as time dilation, length shortening and most importantly relativistic (kinetic) mass increase with velocity, **relative to the outside observer**.

Fact 3: The universe is there to be explored, not just remotely, but by going there.

Fact 4: The limit on speed, put by Einstein as the speed of light as seen by **an outside observer**, and called the cosmic speed, was deduced by a mistaken interpretation of the basic equations of the special relativity (SR) and did lead to a halt in more serious studies of beyond-speed-of-light (BSOL) transport which is necessary if mankind has to explore the universe physically.

Let us see what Einstein himself says in [1] in his own words: " *From this we conclude that in the theory of relativity the velocity* ***c*** *plays the part of a limiting velocity, which can never be reached nor exceeded by any real body. Of course this feature of the velocity* ***c*** *also clearly follows from the equations of the Lorentz transformation, for these become* ***meaningless*** *if we choose values of* ***v*** *greater than* ***c****."*

Here the word "meaningless" is actually not adequate as shown below.

The deduction that "*c* can never be reached nor exceeded by any real body" is not explained.

Also when Einstein talks about "*the kinetic energy of a material point of mass m being equal to* $\frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}$. *This expression approaches infinity as the velocity v approaches the velocity of light c. The velocity must therefore always remain less than c.*"

Here again the deduction is not correct. He is talking exactly about apparent (relativistic kinetic) mass seen by the **outside observer**, which has nothing to do with the (rest) mass seen by the traveler inside the vehicle.

All these conclusions are physically wrong even according to the principle of Special Relativity (SR).

The first mistake was in interpreting Special Relativity (SR). The expressions for time elongation, shortening of length and increase in mass are for what an outside observer sees looking at a moving body. These phenomena are apparent only to the outside observer. As for the person riding in the moving vehicle, none of the quantities of time, length nor mass will change.

The second mistake was that Special Relativity (SR) considered, that as the quantity $\sqrt{1-\frac{v^2}{c^2}}$ **goes imaginary mathematically, when *v* > *c*, then that is an indication that it is physically impossible and the velocity *c* hence shall play the role of a limiting universal velocity. While in actual fact the imaginary number can be physically explained as going into another aspect or realm of matter; invisibility by the earth-bound outside observer,**

time warping (TW), where the laws of special relativity (SR) are applicable in a speed vector normal (or orthogonal) to the below- speed-of-light (BSOL) speed vector.

Fact 5: Special relativity dictates that as an object moves faster, its relativistic (kinetic) mass increases, but faster here, is measured relative to an observer who is also measuring the mass. If the person measuring the mass is moving along with the object, this observer will not observe any change of mass. Therefore, the increase of mass is an **apparent increase to the observer from outside,** not a real increase.

Fact 6: From the equation of time elongation:

$$t_1' = \frac{t}{\sqrt{1 - \frac{v^2}{c^2}}}, \qquad (1)$$

it is clear that as v approaches c, t_1' tends to infinity. At $v = c$, for the outside observer the clock inside the vehicle will seem to have stopped, while it is still working normally inside the vehicle. The length of the vehicle will seem to be zero for the outside observer, which makes the vehicle invisible relative to the outside observer. At the same moment the mass (relativistic) and its energy will seem to be infinite relative **to the outside observer**.

When $v > c$, t_1' becomes an imaginary number to the outside observer. Physically that does not mean that v cannot exceed the value of c, but that the outside observer cannot measure it anymore. Imaginary numbers and complex numbers are extensively used not to show impossibility, but to indicate a different physical aspect. Applying this to our case it can be readily seen that crossing the speed of light barrier can be possible and cannot be denied just because the outside observer does not see the object traveling at $v > c$. This can be explained by

warping time (TW).

The same logic can be applied to the law of shortening the length:

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

Here at $v=c$, the vehicle length will seem to be zero to the outside observer which makes the vehicle invisible to the **outside observer**, but inside the vehicle all is as usual. At $v > c$, L' will seem to be imaginary to the **outside observer** and he cannot see the vehicle.

Again the same logic can be applied to the change of relativistic (kinetic) mass with respect to the **outside observer** for $v=c$ and $v > c$.

Fact 7: That being the case, and taking as an example this last relationship [2], we can write for $v > c$:

$$L' = L\sqrt{\frac{v^2}{c^2}-1} = jL\sqrt{\frac{v^2}{c^2}-1} \qquad (3)$$

Here we see that as v increases, L' also increases. This is the reverse of the case for when $v < c$. This reversal in results applies to time elongation t'

$$t' = -j\frac{t}{\sqrt{v^2/c^2-1}} \qquad (4)$$

and to the relativistic mass.

3. Results from facts

The above facts lead us to the following results:

Conclusion 1: An object, per se (i.e. irrespective of what an **outside observer** will see), can move at any speed it can attain without any changes to its physical properties in mass, size….etc.

Conclusion 2: There is nothing in special relativity (SR) that forbids traveling at speeds faster than the speed of light (BSOL), except that as the object approaches the speed of light, an **outside observer** will observe that its relativistic (kinetic) mass is increasing and approaching infinity and its length is decreasing and approaching zero. All that is only **apparent** to the outside observer. But the object, per se, is the same and nothing will have happened to it.

As the object trespasses the speed of light, for **the outside observer** in his frame of reference, the object will disappear from his vision.

Conclusion 3: The negativity of t' when $v > c$ is an indication of going back in time, which is true. This indicates that traveling at $v > c$ means going to the past.

Fact 8: Increasing the speed of an object needs energy and the amount of apparent relativistic energy required to reach the speed of light is infinite.

Conclusion 4: In order to travel at speeds above the speed of light (BSOL) in cosmos, scientist and engineers should look for:

a) Low cost very high energy sources.

b) Ways to counteract the effects of gravity. Physicists must concentrate on discovering the nature and secrets of gravity which will lead to ideas to counter gravity. BSOL does need materials with gravitational repulsive properties.

Final Conclusion

The above proves that mass can move at a speed higher than the speed of light (BSOL) with respect to an outside observer's frame of reference. This is a big step forward for the future real travel in cosmos. Very interesting results are obtained for when $v > c$ when looking at the basic equations of special relativity (SR).

A final question comes to mind after proving the feasibility of BSOL travel, and I address it to physicists, cosmologists and astronomers; as matter can move BSOL, couldn't there be cosmic bodies in the universe moving BSOL relative to us (the outside observers) but we do not see them?

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Biography

Omar A. H. Shabsigh received the BSEE in telecommunications engineering in 1958 from Alexandria University, Egypt and the PhD from the Academy of Telecommunications in St. Petersburg, Russia in 1977. He is professor of telecommunication at the University of Damascus since 1965 and a telecommunications and computing consultant since 1985. He is a member of the Arab Scientific Academy in Damascus. He is a life member in the IEEE. He has 41 books and tens of articles published.