Special Relativity: The Revival of Metaphysics

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Version 1.0 - 1 5 April 2018

Abstract

Special Relativity (SR) was introduced to the scientific world as a revolutionary new compound of ideas. The theory rightly rejected the idea of aether and presented the first case of uncertainty in physics, *i.e.* the absolute speed of no known frame is known[1]. But, was SR really a paradigm shift in science or, in general, a giant step in wrong direction? Sceptics might think that SR brought ambiguities such as the twins paradox or relativistic mass but the main undesirable effects of SR, when it was presented in 1905, were:

1. Insisting on contemplating alone for discovering the reality of the universe with supposedly one unerring cool tool, *thought experiment*.
2. Introducing an instrument, *e.g.* the light clock with a supposed working characteristic that is not yet experimentally proven.
3. Introducing the constant relative speed, between two inertial reference frames (IRF), into the experimental setting. It then tried to do thought experiment in the new setting using the light clock. This introduction brought some challenges which SR tried to fix by time dilation, length contraction and relativistic mass.

Relativistic mass was reluctantly excluded from SR by Einstein in a letter to L. Barnett[2] in June 1948 [2]. But as relativistic mass was part and parcel of SR it was not quite easy for scientific community to part with it and forget about it[3]. The subject is still under debate but by the end

[1] In 1904 Poincare wrote "The principle of relativity, according to which the laws of physical phenomena should be the same, whether to an observer fixed, or for an observer carried along in a uniform motion of translation, so that we have not and could not have any means of discovering whether or not we are carried along in such a motion". [1]

[2] "It is no good to introduce the concept of mass of a moving body for which no clear definition can be given. It is better to introduce no other mass concept than the rest mass *m*. Instead of introducing *m*, it is better to mention the expression for the momentum and energy of a body in motion" [2].

[3] A book written by L. Barnett, with a forward by Einstein - signed on 10 September 1948, [3] has no sign of excluding the concept of relativistic mass from special relativity. In fact, relativistic mass has been given the most favourable coverage. For example, "And indeed the most important practical results of Relativity have arisen from this principle—the relativity of mass." or "Since a body of infinite mass would offer infinite resistance to motion the conclusion is once again reached that no material body can travel with the speed of light. Of all aspects of Relativity the principle of increase of mass has been most often verified and most fruitfully applied by experimental physicists. ... For atomic physicists concerned with these great speeds, the increase of mass predicted by Relativity is no arguable theory but an empirical fact their calculations cannot ignore. In fact the mechanics of the proton synchrotron and other new super-energy machines are designed to allow for the increasing mass of particles as their speed approaches the velocity of light."

of the twentieth century mainstream physics was convinced that relativistic mass should be given a quiet farewell due to its controversial consequences [2], [4-8].

This article summarises the reasons that length contraction and time dilation should have the same fate. The author has already shown that:

1. Following the surprise null result from Michelson and Morley (M&M) experiment, the proposal of length contraction, and later on time dilation, was just based on a simple analytical oversight of the experiment[9] as the movement of the half-silvered mirror was ignored in the analysis. In simple words, length contraction was founded on false foundation. This was a huge blunder that science should not be proud of, in the least, and should have been pointed out immediately and forgotten ever since. But, unfortunately, in the wake of the confusion not only no one noticed the mistake but also length contraction was found to be a useful platform for a new theory, namely special relativity.
   The realisation of this obvious mistake pulls the rug from under ensuing experiments or test theories such as Kennedy–Thorndike experiments [10] or the Robertson-Mansouri-Sexl test theory [11-12] as they rely on length contraction as a proven premise.
2. Time dilation is not a well thought out scientific idea as initially proposed and believed by physicists[13] as the theory is based on one specific position of the moving clock in relation to its observer. This recognition further undermines test results such as the Ives-Stilwell experiment [14].

The article tries to put SR under further scrutiny and suggests SR to be considered as a metaphysical idea attired in an elaborate scientific and mathematical gown, such as the Lorentz Transformation Equation. It tries to dismiss SR experimental setting by a few examples. It shows that the theory can result in cases that even length contraction and time dilation are not able to fix, that is, to make laws of physics to be the same in all IRFs. More examples show why the insertion of relative speed in experimental setting cannot been beneficial to science.

1 Introduction

At the outset of twentieth century two facts were known about light which are still accepted by scientists.

1. Based on Maxwell's equations the speed of light in vacuum, c, is considered as a physical constant,

$$c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$$

   where ε_0 is electric permittivity and μ_0 is magnetic permeability of vacuum, or aether according to Maxwell.

2. One-way speed of light cannot be measured

Could, consequently, constant c be suitably used to settle the absolute speed of everything else? Not, according to the theory of special relativity (SR). SR states that any non-accelerating observer measures the same speed of light emitted from any non-accelerating source that is moving at any direction. This was stated in the beginning of twentieth century by Einstein, and it has been believed since, despite the second fact above. One then wonders what was the scientific grounds upon which SR was proposed and accepted? By then the only real investigation related to the issue was Michelson and Morley (M&M) experiment which Einstein claimed that, at most, it did not have "a decisive role" [15] on his theory.

It thus seems Einstein mainly founded his theory on thought experiments. What is a thought experiment? It is defined as "device of the imagination used to investigate the nature of things" [16]. In science it can be defined as an educated or expert thinking that is not being verified by a real experiment with real instruments. This practice was well exercised by philosophers and metaphysicians of the past, before the new scientific discipline and era taking hold. Two examples of the use of this type of experiments are:

- Galileo's criticism of Aristotle's theory of motion [17]
- Demonstration that in Quantum Mechanics the wave function does not provide a complete description of physical reality. This is known as the Einstein–Podolsky–Rosen (EPR) paradox [18].

Real experiments have shown that Galileo's criticism was correct while EPR paradox was not so. In fact, it has become clear for a long while, e.g. at the beginning of the twentieth century, that this way of doing science can go badly wrong. That is why empirical science found to be necessary companion to pure thinking for the correct understanding of the universe and worthwhile investigation of the nature of things. Unfortunately, scientists, once again, have fallen in love with metaphysics under the glitter of the supposedly ground-breaking idea. Simply, scientific community wrongly accepted that real experiment can be dropped from the investigation process and can be substituted by thinking alone.

Second problem is that Einstein's thought experiments, related to SR, were carried out by the light clock which its working characteristic was not proven experimentally. It is shown[13] that the claimed time dilation in SR is valid only when the clock in a moving frame is positioned perpendicular to the direction of relative movement. More than a century later the clock is still the key instrument for doing experimentation in SR. This is metaphysics through and through.

2 Adding Speed of Objects to Scientific setting?

Let us start with two concepts in SR:

1. Any non-accelerating frame is called an Inertial Reference Frame (IRF) in SR. IRF is a different concept from an Accepted or Assumed Fixed coordinate or Assumed Fixed Frame (AFF) within which classical scientific investigations can be carried out.
2. Besides replacing AFF with IRF, SR introduces a new concept which is analysing the events in one IRF observed from a different IRF. Let us call the setting of this type of exploration "SR setting" (SRS).

We want to examine what is the advantage of studying the movements of objects in SRS in comparison with examining them in reference to an AFF. The investigation can be illustrated by a few examples.

2.1 Not All Physical Laws are Binding in SRS

Let us start with a simple example. Figure 1 shows the ideal-elastic trajectory of a ball which is thrown at a hard and flat surface. Based on this type of experiments in an AFF system, we have a law in classical physics that the angle of reflection is the same as the angle of incidence. The same law is true for a beam of light shone on a flat mirror.

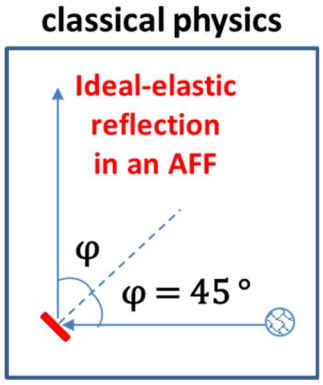

Figure 1

One of the postulates of SR is that the laws of physics are the same for all frames of references moving at constant speeds with respect to each other[4]. However, the reflection law is not anymore true if the ball (or light) movement is studied in SRS. For example, if the experiment is observed by someone who is moving with the relative speed of v parallel to the reflection flight of the ball, as shown in Figure 2, the angle of reflection is always the same for any angle of incidence. The latter angle depends on the relative speed between the frame and the observer, v.

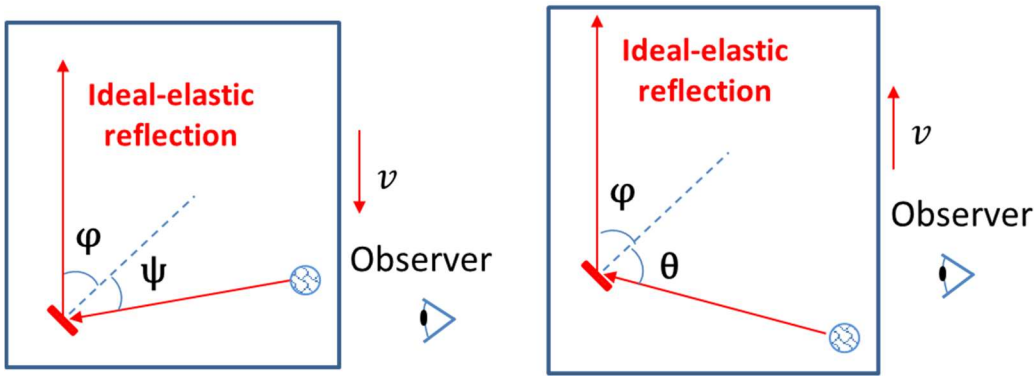

Figure 2

In general, the angle of reflection can be smaller, equal or larger than the angle of incidence if observed from different IRFs.

[4] See footnote 1, also "The same laws of electrodynamics and optics will be valid for all frames of reference for which the equations of mechanics hold good" [19]

This example clearly shows that, in clear contrast to one of the main postulates of SR, not all physical laws are binding in SRS. Moreover, one should not bend or alter a physical law or, even worse, change the geometry of the universe to make the law persists in SRS as it does in AFF. Note that even length contraction and time dilation do not help with upholding the law of physics in this example within SRS.

This experiment is shown in SR sources only when the flat surface is parallel to the relative speed. In this case the angle of reflection is the same as the angle of incidence. This is not the first time that SR is demonstrated to be true only in very limited cases. The author has already shown[13] that the light clock is also positioned only perpendicular to the relative speed between two IRFs to function as it is desired by SR. Any deviation from perpendicular position is not even imagined.

2.2 Lack of Quantitative Details in SRS

Suppose Bob and Alice are sitting on board of two trains each of which is either stationary or smoothly moving parallel to each other with a constant speed. The relative speed between the two trains is v_T. In this example, the ground on which the trains are operating is a suitable AFF. Consequently, both observers can accurately measure the (vector of) speed of each train relative to the ground. In contrast, in special relativity each train can be considered as an IRF and neither Bob nor Alice is supposed to be aware of any other objects or frames such as an AFF but the trains and their contents. The parallel movements of the trains can be any of the 5 main possibilities shown in Figure 3, measurable in an AFF system.

In SRS case, both observers cannot say whether any of the trains is stationary or moving at a certain speed and direction. The trains can have any speed and direction, unknown to both. The only accepted measurement to both is the quantity of the relative speed v_T. The direction of the vector depends on the observer.

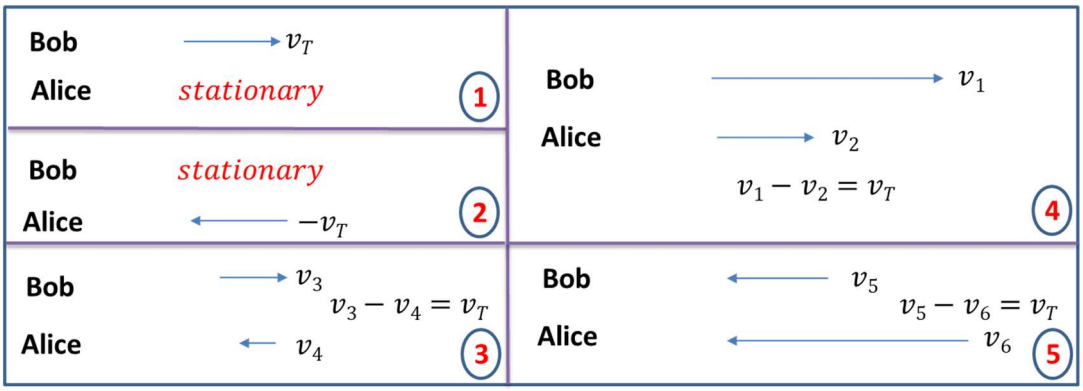

Figure 3 – Unknown Possibilities of Train Speeds and Directions in SRS

Suppose a toy parachute is descending from above with a constant speed. Again, in an AFF setting each observer can determine the exact speed and direction of the toy and the trains. In SR, the speed of the toy according to the observers, v_{Toy_A} and v_{Toy_B} are depicted in Figures 4 for the five possibilities of figure 3.

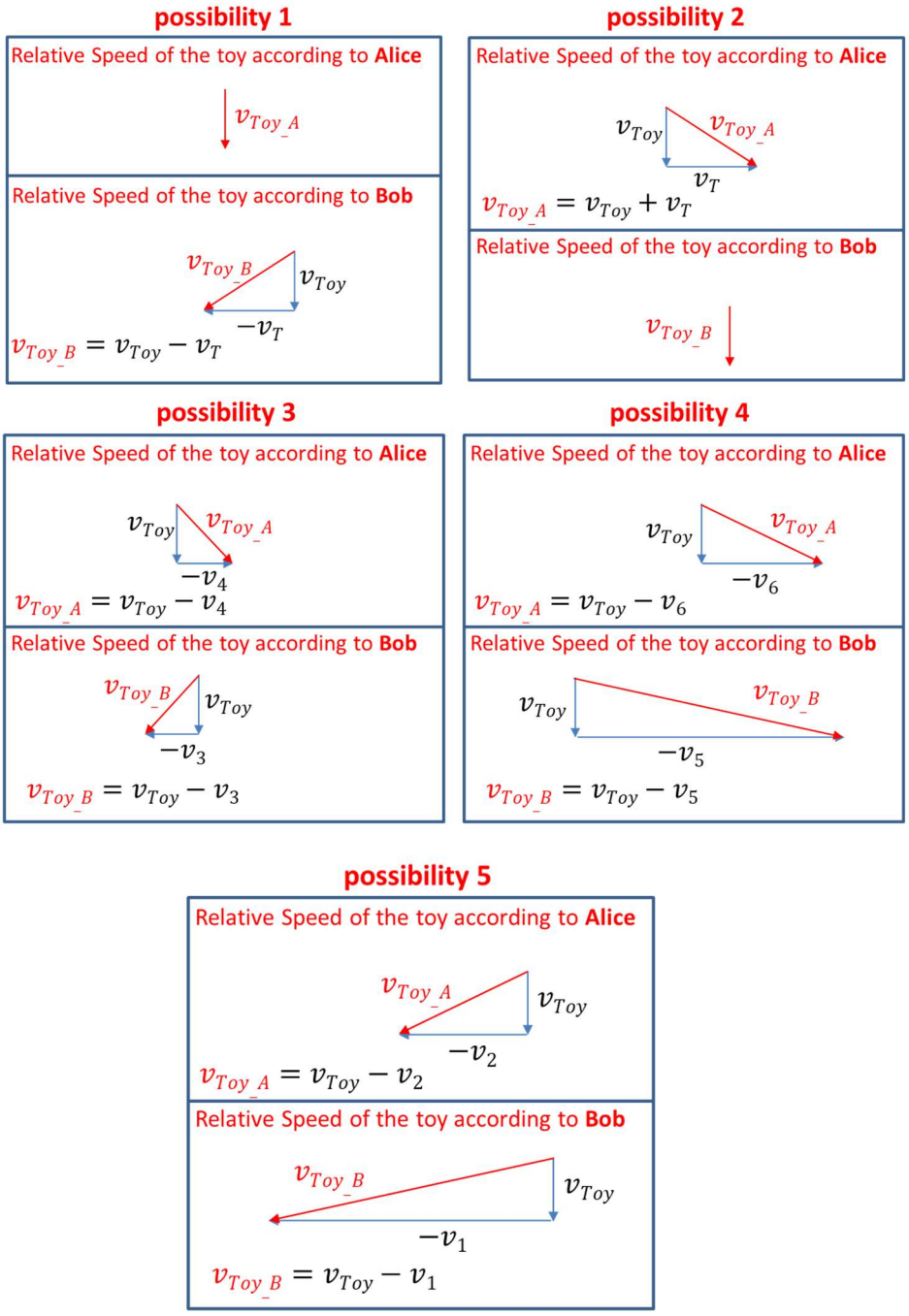

Figure 4

In SRS, the observers can only determine the relative speed between the toy and themselves. They even cannot certainly say if both trains are ascending or the toy is descending. In summary, in SRS, not all quantitative details are known for scientific studies.

2.3 Einstein velocity addition

How is v_T calculated? For a typical train speed, SR accepts the use of simple non-relativistic addition of classical mechanics which provides good enough accuracy.

$$v_T = v_{Bob} - v_{Alice} \tag{2}$$

when the speeds are comparable to c then SR suggests *Einstein velocity addition* formula[19][20] should be used for calculating v_T.

$$v_T = \frac{v_{Bob} - v_{Alice}}{1 - \frac{v_{Bob} v_{Alice}}{c^2}} \quad (3)$$

But this is just fantasy as neither v_{Alice} nor v_{Bob} is known in SR. Both can have any value between – c to + c.

To remedy this situation, it is implicitly or explicitly assumed that:

1. the observer is stationary and other train is moving at the relative speed of v_T.

   This is, obviously, a wrong scientific statement, even it is in contrast to SR itself. We should also remind ourselves of the damaging effect of this type of assumptions. Scientists tried hard to remove the dominating geocentric dogma of the past, and now a comparable assumption is accepted under a new concept.

   Based on this assumption, Equation 3 is simply reducing to either $v_T = - v_{Alice}$ or $v_T = v_{Bob}$, depending on the observer.

2. there is a third reference frame based on which the speeds are measured.

In both cases we are back to AFF system, an assumed fixed reference frame. Only then, with either of these two assumptions, the formulas make sense. Specifically, to be able to present SR as a scientific theory it is forced to accept that the frame of the observer or an AFF is the absolute reference for any measurement or analysis. Somehow, both conflicting cases are accepted in SR quite subjectively. In other words, SR is arbitrarily benefiting from classical science while at the same time denying it.

2.4 Discarding Mathematical Tools

So far, we have noted that IRF study is not the same as AFF study as the former can limit or distort our knowledge and not provide the whole fact. When an IRF is assumed to be a stationary frame we are back to classical physics.

When we consider light, there are a few more challenge. It is generally accepted in modern physics that any nonaccelerating movement of the source of light does not affect the measurement of the magnitude of c. In other words, vector operation is not any more applicable for light, as depicted for two parallel movement cases in Figure 5. The conclusion, according to SR, thus is: quantity and direction of the speed of the source has no effect on c.

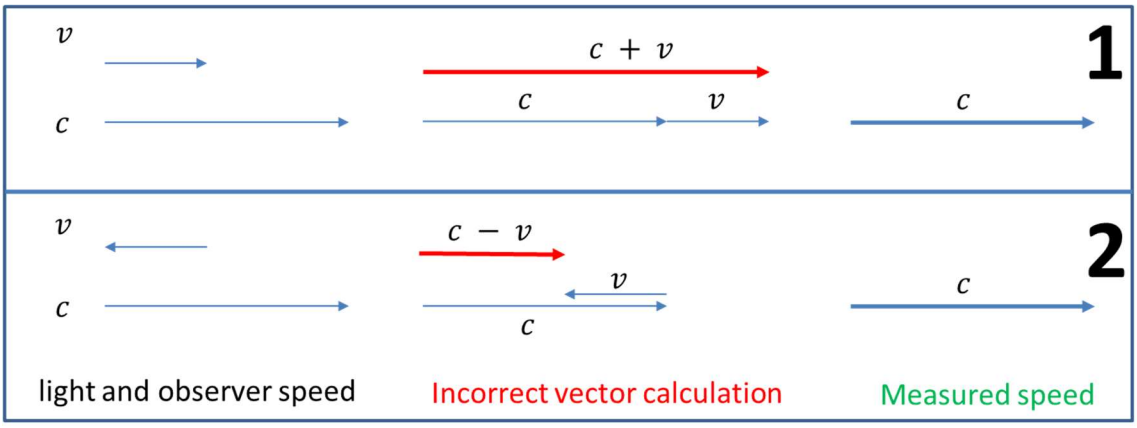

Figure 5 – Vector Presentation of no Quantitative Effect on c

No effect means the direction of light similarly is not affected by the speed of its source for non-parallel cases? Mathematically, it is well justified. However, based on SR, for an outside observer the direction of light is affected by the speed of the source. This is an obvious contradiction.[5]

It is suggested[6] that the directional effect on light is due to the stellar aberration or aberration of light. It has, however, been shown that aberration due to moving star does not agree with our observation of binary stars [22]. Thus, observation and experiment only corroborate aberration due to the observer movement.

Whatever the justification of the directional effect in SR, what we are left with is that vector operation is rendered useless in SRS or partially applicable, as it applies sometimes and does not do so some other times.

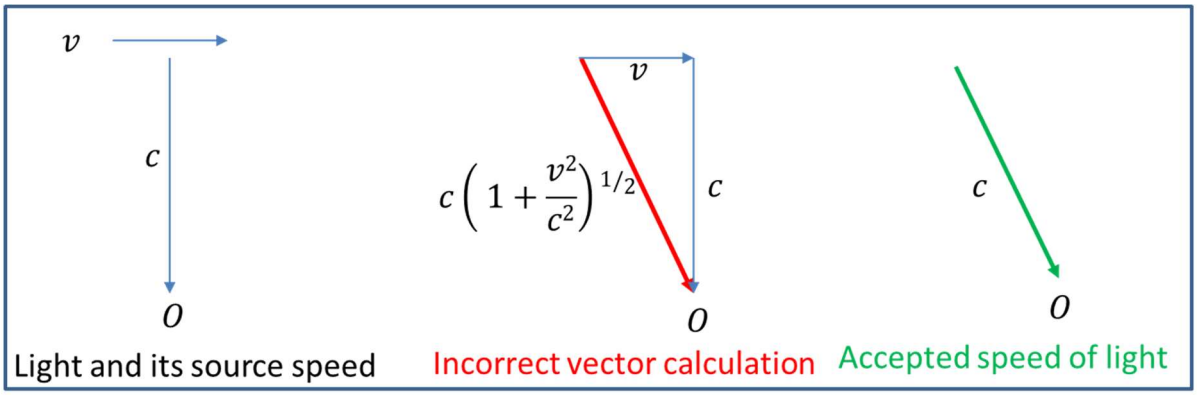

Figure 6 – Vector Presentation of Directional Effect on c

2.5 Time Dilation and Length Contraction

The major application for directional effect is Einstein's light clock. Key conclusions of SR, such as time dilation and length contraction, are based on the analysis of the working assumption

[5] The size of the angle is another issue which will be discussed later.

[6] Thanks to K. Olaussen and R. J. Low [21]. The author, though, does not agree with this suggestion as pointed out in the next section.

of the clock in various thought experiments. Similar to a vertical ball movement within a moving wagon in empty space, the supposed directional effect on the light beam is perceived from a second IRF moving at a constant speed related to the clock. One, however, should note that the beam cannot be observed by the outside observer as it is only bounces in specific directions. Moreover, the aberration of light does not apply for an observer in the frame of the clock as any two points, one on the top and another on the bottom mirror, are stationary in relation to each other.

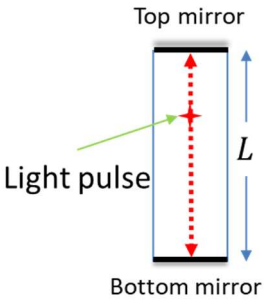

Figure 7 – A Light Clock

It is a SR view that the clock at rest with its observer (both in the same IRF) has a perfect vertical reflection of light irrespective of its unknown orientation and the unknown speed of its IRF, v_{IRF}, that is light behaves like a ball within an IRF. In other words, classical mechanics laws are accepted for light within a frame.

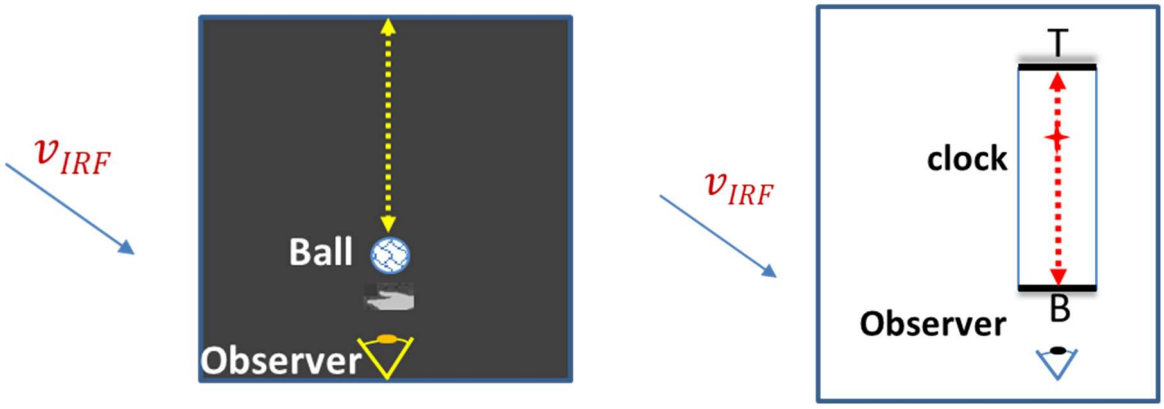

Figure 8 – Similarity Between Light and Ball Movements within an IRF

Therefore, for a resident observer the clock does not go slower or faster, even a single Plank time, no matter if the IRF is stationary or moving close to c. Accordingly, it can be concluded that the pace of aging of all resident observers is a universal constant and is not affected by the direction and magnitude of v_{IRF}.

The question is that whether:

1. The magnitude and direction of beam changes with the speed of the frame, similar to the behaviour of a ball
2. Only the direction of the beam is affected
3. There is an unknown or dark effect which somehow complies with M&M experiment.

Excluding option (3), in reference and accordance to Figure 8 and M&M experiment, one can readily extend the similarity or equivalence between the ball and light cases further to conclude that v_{IRF} must then affect both magnitude and direction of c like it affects the speed of the ball. SR instead chooses option (2) but to incorporate the constancy of c it also has no choice but to accept Lorentz length contraction.

2.5.1 Reason for Directional Effect in SR

According to SR or specifically SRS view of the world, the movement of a light pulse within a moving light clock when observed by a stationary observer is accepted to be the same as the movement of the light pulse within a stationary light clock when observed by a moving observer. Let us call this similarity SRS equivalence.

There is, however, one more problem.

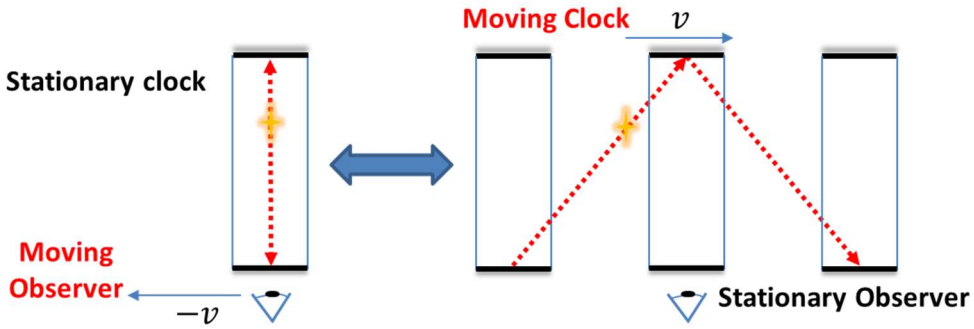

Figure 9 - Clock & Light Track According to the Moving Observer

As the magnitude of c is not affected by the speed of the moving clock, $\boldsymbol{v}$, the angle between light and the speed of the clock, θ, cannot be calculated the same as the angle between the speed of the wagon and the ball movements, φ, when they are observed externally. The angle is calculated by $\mathbf{arccos}(\boldsymbol{v}/\boldsymbol{c})$ and not by $\mathbf{arccot}(\boldsymbol{v}/\boldsymbol{c})$, omitting time and constants for simplicity. Again, the same law of classical mechanics does not apply for light if nothing else is changed.

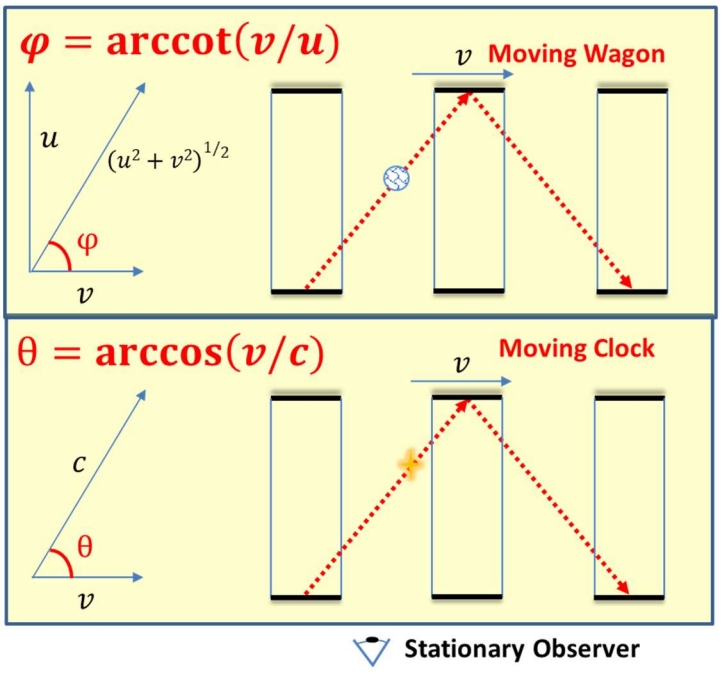

Figure 10 – A Different Rule for Calculating Light Direction

If the magnitude of c was affected by the speed of the moving clock, the angle β in Figure 11 was greater than θ for any $v > 0$. To correct this problem, make θ to be equal to β and consequently to tie the movement of light with classical mechanics, it is required to adjust the adjacent leg by a factor $\boldsymbol{x}$. With reference to Figure 11, $\boldsymbol{x}$ can be calculated as follows:

$$\frac{v}{c} = \frac{vx}{(c^2 - v^2)^{½}}$$

$$x = \left(1 - \frac{v^2}{c^2}\right)^{1/2}$$

$$x = 1/\gamma$$

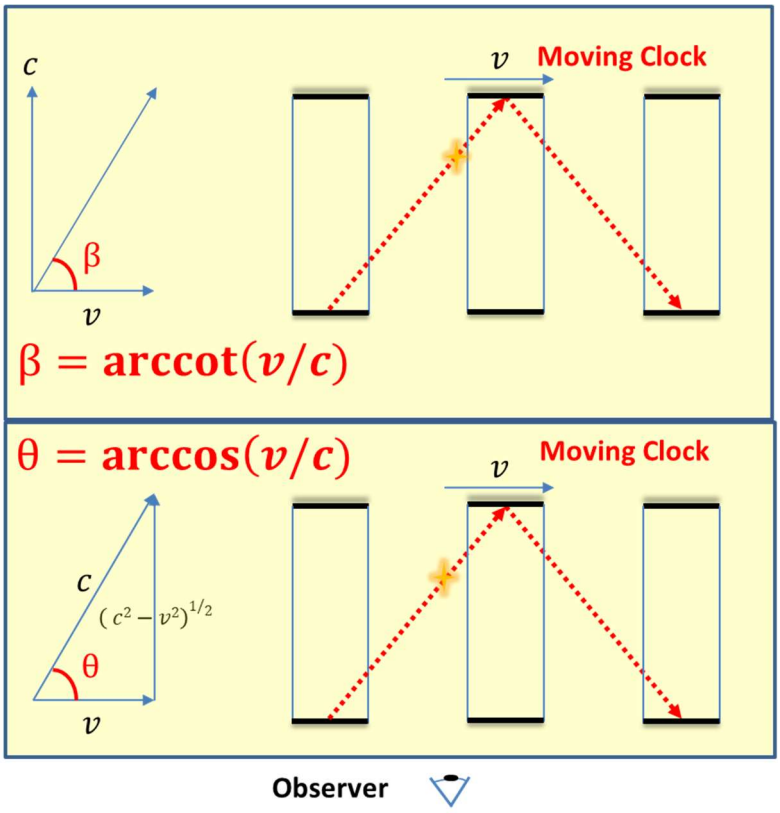

Figure 11 – Analytical Reason for Length Contraction

Meaning that the adjacent leg needs to be contracted by a factor of $1/\gamma$, where γ is Lorentz factor in the direction of the relative velocity between two IRFs. As pointed out this option is discredited by correct analysis of M&M experiment.

To summarise, SRS equivalence forces SR to accept directional effect and then accepting constancy of c forces it to accept Lorentz length contraction to make the behaviour of the

light beam in the light clock tie up with the law of classical mechanics. In this process it accepts partial vector operation and have to rely on discredited length contraction.

3 Uncomfortable fact

Why then we value SRS studies? It brings one important fact to our attention. It exposes the fact that there is no known stationary frame.

Suppose Tom is in a non-accelerating spaceship. If he is unaware of any external object he cannot say whether his spaceship is stationary or moving, let alone its direction of movement. In absence of any evidence he assumes himself and his spaceship being stationary. If Tom looks out of a window and only sees countless other non-accelerating spaceships going at all directions he still cannot say if his ship is moving or stationary. Likewise, he cannot certainly say which ship is moving and which is stationary. The same is true for the occupants of all the other ships. Tom can assume himself or one of the other ships to be stationary and then based on his right or, most probably, wrong assumption the movement of other ships is judged.

Unfortunately, the fact is that like Tom we have not been able to find a stationary frame to measure accurate and absolute movement of any other objects in the world. SR, by presenting SRS exploration, introduced the first uncertainty or unawareness case in modern physics. That is, *the absolute speed of no known frame is known*. In fact, according to Maxwell's equations and SR the absolute speed of no known object but light in vacuum is known.

AFF, on the other hand, is the only solid platform for science but there is no known solid platform in universe. What is the way out? By accepting the fact of non-existence of a global stationary frame we can still avoid studying almost all phenomena of the world presented in two or more IRFs by having a reference frame which is constant in relation to the movements under investigation. This is exactly what SR is forced to accept. The problem in SR is that it allows switching between AFF at will.

In fact, our simple two trains example can only be studied in SRS if we play ignorance - by neglecting some obvious facts, say, by discounting all other objects outside the trains or the pull of their locomotives - just to satisfy ourselves that we are merely able to measure the relative speed between the trains. Likewise, the physical characteristics of any clock are better to be investigated in relation to an AFF.

4 conclusions

SR has been constructed on a few premises. One of the main premises is based on an obvious mistake by FitzGerald and Lorentz following their analysis of the null result from M&M experiment. The result of this oversight, not checking the movement of half-silver mirror in the experiment, was the introduction of length contraction. Larmor and Lorentz then added the idea of time dilation. Eventually, Lorentz Transformation Equations (LTE) were developed. Both ideas and LTE were accepted by SR based on thought experiments with the light clock with its unproven and inconsistent working characteristics. The ideas of relativistic mass, momentum and energy duly followed.

Relativistic mass was found the most controversial by physicists and it is gradually dropping from relativity physics.

The author has already identified the mistake that resulted in length contraction and has also shown that time dilation cannot be considered as a scientific theory.

This article further tries to show that

1. SR is in fact a metaphysical idea as it
    a. Created instruments with imaginary and inconsistent working characteristics such as the light clock for scientific investigations
    b. Trusts thought experiment as a trusted substitute to real experiment
    c. Bends or alters physical law and changes the geometry of space without any real experimental validation
    d. Rendered useless a trusted mathematical tool/operator *i.e.* vector
    e. Plays ignorance and does not possess necessary quantitative details for scientific studies
2. Its postulates are not always binding
3. it relies on and uses the concepts of classical physics subjectively while at the same time tries to deny them

The positive points of SR are the facts that it rejected the theory of aether and brought to attention that the absolute speed of no known frame is known.

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