On the Special Theory of Relativity

Bertrand Wong
Eurotech, S'pore Branch
e-mail: bwong8@singnet.com.sg

Special Relativity Theory (SRT) has two postulates, one stating that the laws of physics are the same for all observers, and the other stating that the speed of light is the constant 186,000 miles per second, regardless of any reference frames. As a result of these postulates, SRT renders predictions such as: **1)** No object can travel faster than 186,000 miles per second (the speed of light itself); **2)** On approaching the speed of light, a moving object contracts in length in the direction of motion, while **3)** a clock traveling with the object slows down; **4)** The mass of an object multiplied by the square of the speed of light gives energy ($E = mc^2$); *i.e.*, mass could be converted to energy and *vice versa*; **5)** Observers do not agree on the simultaneity of events - two events that are simultaneous for one observer might not be simultaneous for another.

There are evident inconsistencies among these predictions. There is also a philosophical problem relating to the nature of reality. Could there be more than one reality in Nature; that is, can reality be subjective, and only a matter of interpretation? This paper explores the evident inconsistencies and the philosophical problem by developing arguments and providing numerical examples.

1. Introduction

Albert Einstein proposed the Special Theory of Relativity (SRT) in 1905 in his article "On the Electrodynamics of Moving Bodies". SRT has two postulates, as is stated in the Abstract above, from which is derived the motion of particles moving at close to the speed of light; it propounds the laws of motion for any particle. This does not mean Newton's theory was wrong. Newton's equations are contained within the relativistic equations, and are valid for velocities much less than the speed of light. For particles moving at low speeds, very much less than the speed of light, the differences between Einstein's laws of motion and those derived by Newton are very small. This is the reason why relativity does not play a large role in everyday life. SRT is now very well established as the description of motion of relativistic objects, *i.e.*, those traveling at a significant fraction of the speed of light. It supersedes Newton's theory, but Newton's theory provides a very good approximation for objects moving at everyday speeds.

2. Illusion

SRT predicts that, upon approaching the speed of light, clocks slow down, moving objects contract in length in the direction of motion, and, a person's brain and bodily functions slow down. For example, a person on a moving vehicle (moving frame) that travels beside a beam of light (moving frame) in the same direction, and almost as fast as the beam of light (moving frame) itself, gauges the speed of the beam of light (moving frame). SRT predicts that this person on the moving vehicle (moving frame) traveling at almost the speed of the beam of light (moving frame) would find the speed of the beam of light (moving frame) to be unchanged, at 186,000 miles per second; this instead of the difference between the speed of the moving vehicle (moving frame) and the speed of the beam of light (moving frame), which would normally be the case.

This is claimed to be the case because, according to SRT, on the moving vehicle (moving frame) approaching the speed of light, the clock therein used to gauge the time traveled by the beam of light (moving frame) has slowed down by the same degree (say X %) as the ruler or measuring device therein used to gauge the distance traveled by the beam of light (moving frame) has contracted in length in the direction of the vehicle's motion (also X %), the greater the moving vehicle's traveling speed the more the clock slows down and the greater the length contraction of the ruler or measuring device.

All this is expressed in the following equation, which is in accordance with SRT:

$$\frac{186{,}000 \text{ miles} - X \text{ \% of } 186{,}000 \text{ miles}}{1 \text{ second} - X \text{ \% of } 1 \text{ second}} = 186{,}000 \text{ miles per second}$$

But (and this is a very important 'but'), if the moving vehicle's clock had not slowed down, and its ruler or measuring device had not contracted in length, (*i.e.*, under normal conditions), then the speed of the light beam (moving frame), as gauged from the vehicle traveling besides it at almost the speed of light (moving frame), would have had been the difference between the speed of the light beam (moving frame) and the speed of the moving vehicle (moving frame); *e.g.*, 186,000 miles per second (speed of the light beam) minus 185,990 miles per second (speed of the moving vehicle), which is equal to 10 miles per second.

Thus, the speed of the light beam (moving frame), *i.e.*, 186,000 miles per second, as gauged from the vehicle traveling besides it at almost the same speed (moving frame) in the same direction is evidently an *illusion*, which is somewhat similar to the situation whereby a driver in a car which is actually cruising at 60 miles per hour believes that his car is traveling at 30 miles per hour because the car's speedometer, which happens to be faulty, gives a reading of the car's cruising speed as 30 miles per hour instead of 60 miles per hour; *i.e.*, the driver is misled by the car's faulty speedometer.

In the above-mentioned case, the person on the vehicle traveling at almost the speed of light (moving frame), say a space-ship, would not notice that his clock is ticking more slowly, time is passing more slowly for him, he is aging more

slowly, and the length of the ruler or measuring device on his space-ship (moving frame) has contracted in the direction of motion (because there is nothing to compare with).

According to SRT, when this traveler on the space-ship traveling at almost the speed of light (moving frame) looks at a clock on Earth (stationary frame), he would perceive that the clock has slowed down, and when he looks at a ruler or measuring device on Earth (stationary frame) he would perceive that it has become shorter. But, this is evidently only an illusion, and not true, and, the clock ticking away on Earth (stationary frame) is actually ticking more quickly (which implies that time is passing more quickly) as compared to the traveler's clock on the space-ship traveling at almost the speed of light (moving frame), and the ruler or measuring device on Earth (stationary frame) is actually longer as compared to the traveler's ruler or measuring device on the space-ship traveling at almost the speed of light (moving frame) - according to SRT, the clock on the space-ship traveling at almost the speed of light (moving frame) has slowed down and both the length of the space-ship traveling at almost the speed of light (moving frame) and the length of the ruler or measuring device on this space-ship (moving frame) have contracted in length in the direction of motion, whilst the clock on Earth (stationary frame) has not slowed down and the ruler or measuring device on Earth (stationary frame) has not contracted in length. The person on Earth (stationary frame) would also notice the same things that the person on the vehicle traveling at almost the speed of light (moving frame) notices, *i.e.*, the both of them notice the same things about one another.

The other thing each of them would agree on, which is important, is the constancy of light speed: 186,000 miles per second. Since neither of the two parties (on Earth (stationary frame) and on the space-ship traveling at almost the speed of light (moving frame)) had been aware that their respective clocks had been ticking away at different speeds, and, the lengths of their respective rulers or measuring devices had been different, each of them would have regarded the times shown by their respective clocks as the actual time and the lengths displayed by their respective rulers or measuring devices as the actual length, in which case there would be two sets of actual time and actual length, *i.e.*, two sets of reality, a quite absurd situation.

As the third party looking on at the two cases described above and being aware of the circumstances, we could regard the time presented by the clock on Earth (stationary frame) as the actual or correct time and the time presented by the clock on the space-ship traveling at almost the speed of light (moving frame) as the distorted time. Also, as the third party who is all too familiar with the Special Theory of Relativity we could regard the length of the ruler or measuring device on Earth (stationary frame) as the actuality, and the length of the ruler or measuring device on the space-ship traveling at almost the speed of light (moving frame), which has contracted in the direction of the space-ship's motion, as the distorted length.

3. Inconsistency

We here consider the example of two space-ships traveling almost next to one another in the same direction, one (we call it X, which is a moving frame) traveling at almost the speed of light, say, 185,000 miles per second (as gauged from Earth, a stationary frame) and the other (we call it Y, which is another moving frame) traveling also at almost the speed of light, say, 185,500 miles per second (as gauged from Earth, the stationary frame). (Theoretically, no space-ship could travel at the speed of light - the Special Theory of Relativity posits that at the speed of light everything would be at a standstill - the mass of the space-ship would be infinite and the space-ship would not be able to accelerate anymore, the space-ship's length would have shrunk to zero and any clock within the space-ship would have stopped beating, registering zero time.) The speed of Y (moving frame) as gauged from X (moving frame) or vice versa is computed by using the following formula, as is posited by the Special Theory of Relativity:

$$v = \frac{b - a}{1 - ba / c^2}$$

where $c =$ speed of light = 186,000 miles per second, $b =$ speed of Y, = 185,500 miles per second (= 0.9973118c), $a =$ speed of X, = 185,000 miles per second (= 0.9946236 c)

$$\therefore\ v = \frac{0.9973118c - 0.9946236c}{1 - 0.9973118c \times 0.9946236c / c^2}$$

$$= \frac{0.0026882c}{1 - 0.9919498c^2 / c^2} = \frac{0.0026882c}{0.0080502}$$

$$= 0.3339295c \text{ (33.39295 \% of speed of light)}$$

$$= 0.3339295 \times 186{,}000 \text{ miles per second}$$

$$= 62{,}110.887 \text{ miles per second}$$

$\therefore$ speed of Y as gauged from X = plus 62,110.887 miles per second (and not plus 500 miles per second (185,500 miles per second minus 185,000 miles per second), which should normally be the case - Y (moving frame) should appear to the traveler in X (moving frame) to be moving away from X (moving frame) in the same direction)

$\therefore$ speed of X as gauged from Y = minus 62,110.887 miles per second (and not minus 500 miles per second (minus (185,500 miles per second minus 185,000 miles per second)), which should normally be the case - X (moving frame) should appear to the traveler in Y (moving frame) to be moving away from Y (moving frame) in the opposite direction)

What would be X's and Y's respective speeds then (when gauged from the other), when X (moving frame) and Y (moving frame) travel in opposite directions (instead of the same direction)? The speed of Y (moving frame) as gauged from X (moving frame) and the speed of X (moving frame) as gauged from Y (moving frame) should each not exceed 186,000 miles per second, the speed of light, which represents the ultimate limit, the maximum possible speed any accelerating object could attain, as is postulated by the Special Theory of Relativity (and not respectively 370,500 miles per second (185,000 miles per second

plus 185,500 miles per second), which should normally be the case), and, they are computed by using the following formula (which is described further on), which is in accordance with the Special Theory of Relativity:-

$$v = \frac{a + b}{1 + ab / c^2}$$

where c = speed of light = 186,000 miles per second, a = speed of X = 185,000 miles per second (= 0.9946236c), b = b speed of Y = 185,500 miles per second (= $0.9973118\,c$)

$\therefore$

$$v = \frac{0.9946236c + 0.9973118c}{1 + 0.9946236c \times 0.9973118c / c^2}$$

$$= \frac{1.9919354c}{1 + 0.9919498c^2 / c^2} = \frac{1.9919354c}{1.9919498} = 0.9999927c$$

$$= 99.99927\ \%\ \text{of speed of light}$$

$$= 0.9999927 \times 186{,}000\ \text{miles per second}$$

$$= 185{,}998.64\ \text{miles per second}$$

$\therefore$ speed of Y as gauged from X = speed of X as gauged from Y = 185,998.64 miles per second (Y (moving frame) should appear to the traveler in X (moving frame) to be moving towards X (moving frame) in the opposite direction, and, X (moving frame) should appear to the traveler in Y (moving frame) to be moving towards Y (moving frame) in the opposite direction)

How strange and counter-intuitive it is to find the speeds of X (moving frame) and Y (moving frame) to be minus 62,110.887 miles per second and plus 62,110.887 miles per second respectively as gauged from Y (moving frame) and X (moving frame) respectively (and not minus 500 miles per second and plus 500 miles per second respectively, which should normally be the case) in the first case above, and, to be each only 185,998.64 miles per second (less than the speed of light (186,000 miles per second) and not respectively 370,500 miles per second (185,000 miles per second plus 185,500 miles per second), which should normally be the case) in the second case above, one may think. Evidently, the respective clocks in X (moving frame) and Y (moving frame) were slowing down at different speeds and the respective rulers or measuring devices in X (moving frame) and Y (moving frame) were contracting in length to different extents, since the respective speeds of X (moving frame) and Y (moving frame) are different, *viz*., 185,000 miles per second and 185,500 miles per second respectively (the higher the speed of the space-ship the more its clock would slow down and the more the length of its ruler or measuring device would contract).

As found by SRT, both the travelers in X (moving frame) and Y (moving frame) would each see the other's clock as being slower to the same degree and the other's ruler or measuring device as being shorter to the same degree. The dilemma here is to decide whether the clock on X (moving frame) or the clock on Y (moving frame) is giving the correct reading in time and whether the ruler or measuring device on X (moving frame) or the ruler or measuring device on Y (moving frame) is providing the correct measurement in the distance traveled/measured. It is evidently very difficult to decide thus. The travelers in X (moving frame) and Y (moving frame) would each naturally think that everything is fine and consider their respective gauging of the other's speed as correct (assuming that they have no knowledge at all about the Special Theory of Relativity).

However, if the travelers in X (moving frame) and Y (moving frame) noticed that the other's clock had been slower and the other's ruler or measuring devices had been shorter, they might each be puzzled and might each wonder whether whose clock and ruler or measuring device are accurate (assuming that they have no knowledge of the Special Theory of Relativity). Of course, if they had known the principles behind SRT, they would have realized that this phenomenon had been the result of "distortion" due to the creation of an intense gravitational field through travel at almost the speed of light, *i.e*., the slowing down of their respective clocks and the contraction in the lengths of their respective rulers or measuring devices are transient (they are not permanent - X's and Y's respective clocks would beat at the normal rate and the lengths of their respective rulers or measuring devices would return to their original length once the speeds of X (moving frame) and Y (moving frame) have returned from almost the speed of light (185,000 miles per second and 185,500 miles per second respectively) to the normal speeds, according to the Special Theory of Relativity).

The important question is if the spaceships', X's and Y's, times and length or distance measurements are 'distorted' or not real, what should be the real time and real length or distance measurement? The other question, which is very important, that should strike a really sensible mind, is whether a ruler or measuring device, which is rigid and solid, could really contract in length and expand back to its original length in accordance with the Special Theory of Relativity, as is described above, as though it is made of rubber, which is flexible. But, to us, the third party looking on at these two scenarios, who have knowledge of the Special Theory of Relativity, both X's and Y's "real" times and "real" length or distance measurements are illusions and are indeed not real, and, the real time and real length or distance measurement would be those read off a clock and a ruler or measuring device on Earth (stationary frame), where the clock and the ruler or measuring device are free from the "distortional" effect of the intense gravitational field created through travel at almost the speed of light. All this is evidently a case of how we choose to interpret these three scenarios. A philosophical-minded person could choose the other interpretation, *viz*., X's time and length or distance measurement are real to the traveler in X (moving frame), Y's time and length or distance measurement are real to the traveler in Y (moving frame), and, Earth's time and length or distance measurement are real to the resident on Earth (stationary frame), *i.e*., there are different realities. Should there be only one reality? Or should more than one reality be allowed?

We look at the first case pertaining to spaceships X (moving frame) and Y (moving frame) traveling at speeds of 185,000 miles per second (as gauged from Earth, a stationary frame) and 185,500 miles per second (as gauged from Earth, a stationary frame) respectively in the same direction almost next to one another. The speed of Y (moving frame) as gauged from X (moving frame) should normally be plus 500 miles per second (185,500 miles per second minus 185,000 miles per second) and

the speed of X (moving frame) as gauged from Y (moving frame) should normally be minus 500 miles per second (minus (185,500 miles per second minus 185,000 miles per second)), as explained above. But, the speed of Y (moving frame) as gauged from X (moving frame) and the speed of X (moving frame) as gauged from Y (moving frame) should be plus 62,110.887 miles per second and minus 62,110.887 miles per second respectively, as computed by using the formula below, which is in accordance with SRT:

$$v = \frac{b - a}{1 - ba / c^2}$$

where $c =$ speed of light = 186,000 miles per second, $b =$ speed of Y = 185,500 miles per second ($= 0.9973118c$), $a =$ speed of X = 185,000 miles per second ($= 0.9946236c$), so $v =$ $62,110.887 \text{ miles per second}$. For instance, if the length of the ruler or measuring device on the space-ship contracts by 20 % while the space-ship travels at almost the speed of light, the relative speed of plus/minus 500 miles per second of each of the space-ships, X (moving frame) and Y (moving frame), should be recomputed/gauged as follows to produce the 'distorted' speed of plus/minus 62,110.887 miles per second, which is in accordance with SRT:

$\frac{62,110.887 \text{ miles}}{1 \text{ second}}$ = 400 miles (0.8 of 500 miles - due to ruler length contraction of **20** %, 500 miles are gauged by space- ship traveler as 400 miles) ÷ 0.00644 second (due to clock on space-ship slowing down by **15528** %, 1 second is gauged by space-ship traveler as 0.00644 second)

We now look at the second case pertaining to space-ships X (moving frame) and Y (moving frame) traveling at speeds of 185,000 miles per second (as gauged from Earth, a stationary frame) and 185,500 miles per second (as gauged from Earth, a stationary frame) respectively in opposite directions. The speed of Y (moving frame) as gauged from X (moving frame) and the speed of X (moving frame) as gauged from Y (moving frame) should each normally be 370,500 miles per second (185,000 miles per second plus 185,500 miles per second), as explained above. However, the speed of Y (moving frame) as gauged from X (moving frame) and the speed of X (moving frame) as gauged from Y (moving frame) should each not exceed 186,000 miles per second, the speed of light, which represents the ultimate limit, the maximum possible speed any accelerating object could attain, as found by SRT (and not respectively 370,500 miles per second (185,000 miles per second plus 185,500 miles per second)), which should normally be the case), and, they are computed by using the following formula, which is in accordance with SRT:-

$$v = \frac{a + b}{1 + ab / c^2}$$

where $c =$ speed of light = 186,000 miles per second, $a =$ speed of X = 185,000 miles per second (= 0.9946236c), $b =$ speed of Y = 185,500 miles per second ($= 0.9973118\,c$) $= 185,998.64$ miles per second

For instance, if the length of the ruler or measuring device on the space-ship contracts by 60 % while the space-ship travels at almost the speed of light, the relative speed of 370,500 miles per second of each of the space-ships, X (moving frame) and Y (moving frame), should be recomputed/gauged as follows to produce the "distorted" speed of 185,998.64 miles per second, which is in accordance with SRT:

$\frac{185,998.64 \text{ miles}}{1 \text{ second}}$ =
148,200 miles (0.4 of 370,500 miles - due to length contraction of **60** %, 370,500 miles are gauged by space-ship traveler as 148,200 miles) ÷ 0.79678 second (due to clock on space-ship slowing down by **125.51** %, 1 second is gauged by space-ship traveler as 0.79678 second)

Thus, as is evident from the above examples, which are in accordance with SRT, to arrive at the two speeds, *i.e.*, 62,110.887 miles per second and 185,998.64 miles per second, as well as other speeds, obtained by using the formulas of SRT,

$$v = (b - a) + (1 - ba / c^2) \text{ and } v = (a + b) + (1 + ab / c^2) \quad ,$$

the clocks and the rulers or measuring devices on the space-ships traveling at almost the speed of light would have to each respectively slow down and contract in length **at different rates** (and definitely not at the same rate). The only exception is evidently the case of the constancy of the speed of light, whereby the clock and the ruler or measuring device have to each respectively slow down and contract in length **at the same rate**, giving the **same percentage** decrease in the time gauged and the distance gauged**,** as follows, as found in SRT:

$$\frac{(186,000 \text{ miles} - \text{X \% of } 186,000 \text{ miles})}{(1 \text{ second} - \text{X \% of } 1 \text{ second})} = 186,000 \text{ miles per second}$$

Why is the constancy of the speed of light the **exception**? Was it an adjustment or modification of the mathematics to 'ensure' the constancy of light speed? Could the speed of light not be variable, below, at, and above 186,000 miles per second, at various times, as some have suggested?

4. Conclusion

The important question pertaining to the above-described cases is if the spaceships', X's and Y's, times and length or distance measurements are 'distorted' or not real, what should be the real time and real length or distance measurement?

However, to us, the third party looking on at these two scenarios, who have knowledge of the Special Theory of Relativity, both X's and Y's "real" times and "real" length or

distance measurements are illusions and are indeed not real, and, the real time and real length or distance measurement would be those read off a clock and a ruler or measuring device on Earth (stationary frame), where the clock and the ruler or measuring device are free from the "distortional" effect of the intense gravitational field created through travel at almost the speed of light. All this is evidently a case of how we choose to interpret these three scenarios.

A philosophical-minded person could choose the other interpretation, *viz*., X's time and length or distance measurement are real to the traveler in X (moving frame), Y's time and length or distance measurement are real to the traveler in Y (moving frame), and, Earth's time and length or distance measurement are real to the resident on Earth (stationary frame), *i.e*., there are different realities. Should there be only one reality? Or should more than one reality be allowed?

The other question, which is very important, that should strike a really sensible mind, is whether a ruler or measuring device, which is rigid and solid, could really contract in length and expand back to its original length in accordance with the Special Theory of Relativity, as is described above, as though it is made of rubber, which is flexible. Doesn't length contraction therefore appear absurd?

Another significant related point which should be noted is that (though experimental findings had confirmed that at high speeds, though very much less than the speed of light, clocks slow down) the contraction of rulers or measuring devices in the direction of motion at almost the speed of light is evidently only an inference, with no experimental basis. The point stated just above about the rigidity and solidity of the ruler or measuring device does imply that no experimental basis for such contraction could be expected to be forthcoming; the lack of experimental evidence could as a matter of fact be construed to mean that length contraction is actually an impossibility; even as an inference, it actually appears absurd, as is stated above. Why should people swear by a concept such as length contraction that is not backed by any experimental evidence at all, which is unscientific?

The above-described philosophical problem and inconsistencies, together with the evident lack of plausibility, and, empirical evidence, of length contraction, indeed cast doubt on the soundness of SRT, a shortcoming which should be seriously looked into.

References

[1] A. Beiser, **Concepts of Modern Physics**, Fifth Edition (McGraw-Hill, 1995).

[2] Andrew L. Bender, **SlipString Drive: String Theory, Gravity, And "Faster Than Light" Travel** (iUniverse, 2006/2007).

[3] David Bohm, **The Special Theory of Relativity** (Routledge, 1996).

[4] P.A.M. Dirac, **"The Evolution Of The Physicist's Picture of Nature"**, Scientific American, (May 1963).

[5] Albert Einstein, **"On the Electrodynamics of Moving Bodies"**, Annelen der Physik 17, 891 (1905).

[6] Albert Einstein, **The Meaning of Relativity** (Princeton, 2005).

[7] Joao Magueijo, **Faster Than the Speed of Light: The Story of a Scientific Speculation**, (Perseus, 2003).

[8] Paul Tipler & RalphLlewellyn, **Modern Physics (4th ed.)** (W.H. Freeman Co., 2002).

[9] Bertrand Wong, **"An Aspect Of The Special Theory Of Relativity"**, The General Science Journal, (March 8, 2010).

[10] Bertrand Wong, **"The Special Theory Of Relativity: A Special View"**, The General Science Journal, (March 8, 2010).

[11] Bertrand Wong, **"The Special Theory Of Relativity: Further Views"**, The General Science Journal, (March 18, 2010).