Special Relativity is Wrong

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Abstract:
Using the twin paradox as a stepping stone, the problem with Special Relativity is revealed. The theory of special relativity is based on compounded errors. First Einstein made a fatal reasoning error regarding the property of light, then he applied this wrong idea inconsistently. As a result, the conclusion of Special Relativity is not only against the principle of relativity, but also contradicts its own mathematical base. As a measure of demystification, using the concept of average speed, the critical formulas of Special Relativity are re-introduced and their meaning re-explained.

Keywords: Special Relativity, Twin Paradox, Aether, Ether

1. Introduction

Special Relativity is hard to understand. I was stopped by it in university, and was confused by it once more recently.

If a globe can be put in every classroom to show that the Earth is round, why can't we do the same thing with Special Relativity?

If a theory cannot be understood after 100 years of its publication, there must be some reason. Either the theory is wrong or no one really wants to understand it.

In the following sections, let's go through the twin paradox, and see if it can lead us to anything.

2. The Twin Paradox

Among all the paradoxes of Special Relativity, the most famous one is the Twin Paradox.

According to Special Relativity, a moving clock runs slower, so a person in a high speed moving vehicle will get old slower.

Suppose E(arth) and T(raveler) are twins on Earth. At the age of 20, T starts a space trip. When he returns to Earth 10 years later, T will be 30 and E will be much older, let's say 40. The reason is that the high speed motion makes time pass slower in the spaceship, thus T can be much younger than E.

But the conclusion can also be the reverse.

The most important part of Special Relativity is the principle of relativity. From the standpoint of T, E is in a high speed motion relative to him, thus the clock on Earth should run slower, and E should be much younger.

This is the twin paradox.

3. Solution to the Twin Paradox

One clever solution to this paradox is that E's conclusion is right: T will be much younger indeed. The reason is that one of special relativity's conditions is a uniform motion. The spaceship needs acceleration and deceleration, thus T's conclusion is not right.

This solution has a little problem. Just let T travel more and we will see.

Suppose T travels double the distance at the same speed. How old will E and T be?

Following the original thought, T will be 40 and E will be 60, because both of their clocks would have passed double amount of time.

Here is another thought, let's call it thought B.

T's new journey can be thought of as the old journey plus an extra journey in a uniform motion. For this extra part of the journey, E and T are in exactly the same kind of relative state, so their clocks should not add any difference during this part. This will give us a different result: T will always be 10 years younger than E, no matter how much longer he travels further.

Let's continue thought B in another direction. Instead of traveling longer, let T travel shorter this time, so that all the uniform motion part is cut out. Due to the same reason, this cut-out should not cause any time difference. T will still be 10 years younger than E, even if the acceleration and deceleration cause T only 10 hours!

So, the clever solution does not work.

4. What is wrong with the Solution?

To solve this puzzle, no real effort is needed. E and T are always of the same age, no matter T is traveling or not.

It makes sense that our lifespan is decided by our environment, not by some high-tech aliens traveling in light speed vehicles. The lifespan of aliens is not affected by us either, whether we are moving or not.

So how did we get the twin paradox? Where did our reasoning process go wrong?

I can think of only two possibilities. One is that Special Relativity does not apply to our everyday life scenarios. Another is that the principle of relativity is wrong.

When Einstein invented this theory, he was motivated to use it on electromagnetic waves. Is it safe to extend it to our everyday life scenarios?

While the laws governing electromagnetic waves and our everyday objects may be quite different, time itself is the same. In the twin paradox, the really broken piece is time. If a slower clock does not work in our everyday life, it certainly won't work anywhere else.

As for the principle of relativity, nothing seems wrong. The idea of relative motion was first brought up by Galileo, and then got fully utilized in Newtonian mechanics. Extending the principle of relativity beyond Newtonian mechanics is a big step, but it is not suspicious to me.

As no evident error can be found in our reasoning, our next step is to go to Special Relativity itself, and see if we can find anything wrong.

5. The postulates of Special Relativity

The two postulates in Special Relativity are stated like this in "***On the Electrodynamics of Moving Bodies***"[1]:

1. *The laws by which the states of physical systems undergo change are not affected, whether these changes of state be referred to the one or the other of two systems of co-ordinates in uniform translatory motion*

2. *Any ray of light moves in the ``stationary'' system of co-ordinates with the determined velocity c, whether the ray be emitted by a stationary or by a moving body.*

In "***Relativity: The Special and General Theory***"[2], Albert Einstein explained these two postulates in detail. Let's first try by ourselves to see if we can understand them, and then in a later section, we'll check the explanations given by Einstein.

The first postulate is the principle of relativity. It says that any physical law is not affected by the selection of reference frames, as far as the reference frames are all in uniform motion.

All reference frames mentioned hereafter are in uniform motion, unless otherwise specified.

In the field of mechanical movement, the principle of relativity is shown like this: Newton's second law of motion, $F = ma$, works exactly the same in all reference frames. A short mathematical proof is given below.

Suppose in reference frame C, an experiment about Newton's second law of motion is undergoing. Here we have to prove, given any two reference frames A and B, the observations will lead us to the exact same formula: $F = ma$. In another word, we must get the same acceleration, because we are observing the same experiment (Both F and m are unique) .

In reference frame A, the acceleration is:

$$a_A = \frac{dv_A}{dt}$$

In reference frame B, the acceleration is:

$$a_B = \frac{dv_B}{dt} = \frac{d\left(v_A + v_{AB}\right)}{dt} = \frac{dv_A}{dt} + \frac{dv_{AB}}{dt} = \frac{dv_A}{dt} + 0 = \frac{dv_A}{dt}$$

Where v_{AB} is the relative velocity of reference frame A to reference frame B, which does not change with time, thus leading to $dv_{AB}/dt = 0$.

We can see both reference frames give the same acceleration. Or in another word, Newton's second law of motion are exactly the same in both reference frames.

Because the reference frames A and B are arbitrarily chosen, one of them might be taken as the reference frame C itself. Thus we can get this further conclusion: the reference frame, where the experiment event is happening, has no effect on the experiment itself, whether it is "at rest" or in uniform motion.

In this way, the validity of the principle of relativity, in the field of mechanical motion, is established.

The above mathematical derivation does not require that both reference frames are in uniform motion, only that they have a constant relative velocity. The requirement for reference frame of uniform motion comes from the validity of Newton's second law of motion. As the Earth is orbiting the sun and also has a self spin, all our experiments are actually performed in reference frames of non-uniform motion.

In the proof above, the Galilean velocity addition rule is utilized: $v_B = v_A + v_{AB}$. This rule applies to all relative motions. As it is Galileo who first brought up the idea of relative motion, this rule is named after him, to distinguish it from the velocity combination rule under special relativity.

Based on the Galilean concept that all motions are relative, we can see a hidden condition behind the principle of relativity: all objects follow the rule of relative motion.

For clarity, we can describe the first postulate like this:

- **All reference frames of uniform motion are equivalent. Any physical law behaves the**

same in all of them. Or in another word, the mathematical form of a physical law is unique.

- **All physical objects follow the rule of relative motion.**

Comparing with the first postulate, the second postulate is not so easy to understand.

The difficulty is not in the constant speed of light, as this fact is a common knowledge to all of us. The source irrelevant part is also easy to understand. As light is a kind of wave, it should behave like any other wave, whose propagation speed is not affected by the source.

But what does the "stationary" mean? Which reference frame is stationary ? It cannot be the Earth, as the Earth is in a high speed motion. It cannot be the "Ether" either, because Einstein specifically rejected it in his paper.

As I cannot think of any such stationary reference frame, here I assume that this stationary reference frame is any one. Or in other words, every reference frame is "stationary".

So, the second postulate can be stated this way:
Light travels at the same constant speed in all reference frames.

In this paper, fundamental wrong ideas are highlighted in dark red.

Combining the two postulates, we can see two types of objects in the universe. The first type is all objects in Newtonian mechanics, which follows the rule of relative motion. The second type is light, which does not follow the rule of relative motion.

So, Special Relativity is the mixed result of these two types of objects.

Remember how hard our teachers have tried to explain that there is no ***absolute rest*** in the universe? After all of us seem to have been convinced that **all motions are relative**, here we find an ***absolute motion*** of constant speed *c*. Don't our teachers feel a little sad?

6. Theoretical difficulty in the postulate about light

In this and the following section, all the "second postulate" and "postulate about light" are based on our understanding from section 5.

Let's think a little bit about the second postulate: ***Light travels at the same constant speed in all reference frames.***

If two cars are approaching each other, each driver will see the other car as running much faster than its real speed. If you are running to meet a water wave, you are certainly to meet the wave earlier. In both situations, the Galilean velocity addition rule can be used, and the observed speed is higher than that of the source.

Now suppose an observer is trying to meet light earlier by running towards it. The second postulate says it won't work at all, because the observed speed of light will always be the same.

Can we find any mechanism to support this postulate? If the observed speed of light is always the same, then that can mean only one thing: the observer's motion is affecting the light, so that all his/her efforts get canceled out. Whether light is treated as particles or a wave, do we know of a way to change the speed of light?

Suppose there is one unknown force which can be used to change the speed of light, so that an observer's motion can be canceled out. This force must have a magical power, so that whatever the speed of the observer is, it can always dutifully do its job of canceling.

Now let's put two observers side by side, and one is running toward the light and the other just sits there waiting for the light to arrive. This magical force must be able to affect the light facing the running observer but not the light facing the observer at rest. Now let the side-way distance between the two observers get shorter and shorter, so that only one electron can be put in. Now we can see the real power of this force: it can set a boundary as clear as those in mathematics, so that one side is affected, but the other side is left alone.

How likely is such a kind of force to be found?

7. Does the second postulate have experiment support?

If reasoning cannot settle the problem down, experiment may give us a helping hand.

In the famous Michelson-Morley experiment, in order to remove all possible error sources from the environment, the instruments were put on a platform floating in a pool of mercury.

Today, the recognized speed of light in vacuum is 299,792,458 m/s. I do not know how this number is obtained, but I can imagine the highly sensitive nature of the experiment.

A regular airliner normally operates at a speed slightly slower than that of sound, which is about 340m/s under room temperature. Using an airliner as a moving observer to test the speed of light, the error has to be controlled within about half the speed of sound. That error is about one half in one million.

Now the question is: How many experiments have been done to check the light speed using a moving observer? What kind of accuracy did these experiments provide?

Taking the fact that Special Relativity has troubled millions of us since its birth a century ago, any such effort must have achieved the same publicity as the Michelson-Morley experiment, if its result has the required accuracy.

To my limited knowledge, such experiment does not exist.

Currently, in the International System of Units, meter, the fundamental unit of length, is defined based on the speed of light. Does this guarantee that the second postulate is right?

The answer is no.

If one object follows the rule of relative motion, we only need to know its velocity in any one reference frame. Using the Galilean velocity addition rule, which has withstood the test of several hundred years, its velocity in any other reference frame can be obtained.

As light does not follow the rule of relative motion, we have no tested formula to use. In order to know the light speeds in several reference frames, we have to test the light speed in each of them.

Excluding the motion of the light source, and limiting the observer's motion to the direction of the light, three types of test are needed. The first has an observer at rest; the second has an observer approaching the light; and the third has an observer running away from the light.

The test of the first type has been completed with great accuracy, as can be seen from the currently accepted speed of light. Now only the second and third type are remaining, and both of them are facing the same technical difficulty.

At least the following difficulties are present in the moving observer test:

- All human made objects have relative low speed comparing with light.
- Any motion in the surroundings of the Earth is bumpy in nature.
- The techniques used in the stationary test might not work for a moving observer.

From the above difficulties, it is easy to see that results from such direct experiment still have to wait.

8. How did one exception cause so much trouble?

For simplicity, any motion used in this section means uniform motion.

Just open any book about Special Relativity, some paradoxes are certainly to show up. Only light is singled out, and the whole universe is ruined. How did that happen?

In books where Special Relativity is touched, it is not rare to see that the theory is first introduced by using a light clock, and then the author claims that any other types of clock will have the same effect. Is that true?

Let's try to use a mechanical clock this time.

Based on Newtonian mechanics, no matter the clock is at rest or in uniform motion, all the physical forces acting on it work exactly the same way, thus the clock's time will not depend on the motion state of the clock.

Can we use Newtonian mechanics here?

The answer is absolutely yes.

The first postulate is just an extension to the idea of relativity from Galileo and Newton. This point will be much clearer if the second postulate is removed temporarily. In fact, without Galileo velocity addition rule and Newton's second law of motion serving as its solid foundation, the first postulate won't exist at all.

As for the second postulate, it talks nothing but light. So it does not change any point in the first postulate, thus Newtonian mechanics is not affected in any way.

To remove any doubt on this point, let's review a typical example in high school physics.

In a moving train, an apple on a table fell to the floor. If to one passenger A at the table, it took a specific amount of time for the apple to reach the floor, another observer B on the platform would get exactly the same result. Although to observer B, the apple traveled a much longer distance, but it also got a "free ride", so its overall speed to observer B was also increased.

Now let's replace this apple with light. Can we get the same conclusion? No. The reason lies in the second postulate. Since light does not follow the rule of relative motion, it cannot get a "free ride".

That's why a mechanical clock is not influenced by the motion of its carrier, but a light clock does.

There is another evident difference between a mechanical clock and a light clock. In all books about Special Relativity, the light clocks in the spaceships are always facing the same direction. This is not a coincidence. Just change the direction a little bit, the formula of Special Relativity will be destroyed. A light clock depends on direction but a mechanical clock does not. This difference is also caused by the absolute motion of light and the relative motion of all other objects.

So the types of clock do matter. Different types of clock can lead to different conclusions. Just replace light clocks with any other types of clocks, the universe will be back to normal again.

9. Error in Einstein's reasoning

In his paper [1], why did Einstein use the word "stationary"? Let's have a look at the first step in Einstein's paper:

$$\frac{1}{2}\left[\tau(0,0,0,t)+\tau\left(0,0,0,t+\frac{x'}{c-v}+\frac{x'}{c+v}\right)\right]=\tau\left(x',0,0,t+\frac{x'}{c-v}\right)$$

What does it tell us? There must be a stationary reference frame where we can get *c*, and there must also be a non-stationary reference frame where we can get *c*+*v* and *c*-*v*. In addition to that, light must follow the rule of relative motion, as *c*+*v* and *c*-*v* are all obtained from Galilean velocity addition rule.

So our interpretation of the second postulate is wrong. Although we do not know where to find this stationary reference frame, it must exist. The speed of light used in Special Relativity is relative to this reference frame only.

If we follow this route, then all the paradoxes will disappear, as the conclusion of Special Relativity is valid either in a "stationary" reference frame, or in a moving reference frame, but not in both.

But wait a minute. The principle of relativity seems to be unnecessary. If it is present in his paper, Einstein certainly had use for it. It seems we get lost again.

Let's check "Relativity: The Special and General Theory" for the explanation given by Einstein himself.

In Part I, Section 07, "The Apparent Incompatibility of the Law of Propagation of Light with the Principle of Relativity", Einstein explained this incompatibility like this:

Suppose one beam of light is sent out from the railway embankment, in the same direction where the train is moving. To an observer on the embankment, the speed of this beam is c. To an observer *on the train, the speed of this beam is c-v, where v is the speed of the train. But according to the principle of relativity, the speed of light should be the same, whether the reference frame is the train or the embankment. Thus we get an incompatibility issue.*

Here Einstein's reasoning is wrong. As shown in Section 5 of this paper, the principle of relativity implies that all objects follow the rule of relative motion. So the observed speed c-v is the direct result of the principle of relativity, while the same light speed in all reference frames is against the principle of relativity.

To make this point clear, let's use a falling apple as an example.

In an orchard where a train is passing through, an apple is falling from a tree. To the person standing beside the tree, the apple is falling vertically. To a person on the train, the apple is falling along a path of parabola. Both observations are objective, but they seem to contradict each other. Does this mean the principle of relativity is wrong?

Certainly not. The two observations are both related to the physical law, but they are not the physical law itself. In essence, any physical law represents the relationship between cause and effect. In this example, the falling of the apple is caused by the gravity. If we calculate the acceleration from both observations, the results will be exactly the same number - the acceleration of gravity.

As shown in our proof of the principle of relativity, the difference in observation results is a necessity for the uniqueness of a physical law. The principle of relativity means two things at the same time: a physical law is unique, and all observation results are relative.

Einstein's error here is that he took the observation results as the physical law itself.

From the above analysis, we can see that Einstein's reasoning for "the same constant speed c of light in all reference frames" is wrong, and Special Relativity becomes groundless.

In summary, Einstein used the two postulates this way: The second postulate leads to the constant speed of light in a "stationary" reference frame, and the first postulate leads to the same speed of light in all reference frames.

From a pure technical point of view, the uncertainty in the postulate about light can be fully covered by the following two cases:

- **In the first case, light is a normal wave and follows the rule of relative motion.** Here the incompatibility issue talked about by Einstein does not exist, so no fix is needed.
- **In the second case, light is a special wave and does not follow the rule of relative motion.** As $c+v$ and c-v all come from Galilean velocity addition rule, which works only for objects that obey the rule of relative motion, the first step in Einstein's paper has no physical meaning. As a result, Special Relativity loses its mathematical base.

10. Errors in the conclusions of Special Relativity

A false start does not necessarily mean a wrong ending. So let's have a look at the conclusions of

Special Relativity.

The following equations are two of its conclusions:

$$\tau = t\sqrt{1 - v^2 / c^2} \quad \text{(a clock in motion runs slower)}$$

$$V = \frac{v + w}{1 + vw / c^2} \quad \text{or} \quad v_{\mathrm{B}} = \frac{v_{\mathrm{A}} + v_{\mathrm{AB}}}{1 + v_{\mathrm{A}} v_{\mathrm{AB}} / c^2} \quad \text{(velocity combination rule)}$$

The first equation is about time dilation, which effectively puts a limit to the speed in the universe. If there is no limit for length, no limit for time, why do we need a limit for speed? If the numbering system in mathematics did not have infinity but used a large number as its limit, it would have been broken many times.

If the speed of light c is the speed limit in the universe, does not the $c+v$ in the paper exceed that limit? If a conclusion breaks its precondition, does not that mean this theory is wrong?

The second equation is the velocity combination rule under Special Relativity. Under this transformation,

$$\frac{dv_A}{dt} \neq \frac{dv_B}{dt} \quad (\ a_A \neq a_B\ )$$

So the principle of relativity is broken.

Only in a linear velocity combination rule, like the Galilean one, the influence of a reference frame can be completely removed by the differentiation of velocity with time, if the reference frame is in uniform motion.

If the principle of relativity works so well in this universe, which is introduced by Einstein himself, as can be seen from Part I, Section 05 of [2], why do we have to break it?

The breaking of the principle of relativity is not a surprise. The essence of Einstein's work is trying to build a bridge between relative motion and absolute motion. As relative motion is the base of Newtonian mechanics, which in turn is the foundation of the principle of relativity, any tiny change to the rule of relative motion will destroy the principle of relativity.

So, without going through its mathematical details, we can safely claim that Special Relativity is wrong.

11. More on the self-contradiction in Special Relativity

The time dilation equation puts the speed of light as the speed limit in the universe, and the velocity combination rule leads to the same conclusion, which can be easily checked by replacing either v or w with c.

But in the first step of special relativity, the $c+v$ is an obvious contradiction to the above conclusion.

How did this self-contradiction arise?

The following paragraph comes from the middle of Section 03, Part I, paper [1]:

With the help of this result we easily determine the quantities ξ *,* η *,* ζ *by expressing in equations that light (as required by the principle of the constancy of the velocity of light, in combination with the principle of relativity) is also propagated with velocity c when measured in the moving system. For a ray of light emitted at the time* $\tau = 0$ *in the direction of the increasing* ξ

$$\xi = ct \quad or \quad \xi = \alpha c\left(t - \frac{v}{c^2 - v^2}x'\right)$$

This is the first time when the idea of "the same speed of light in all reference frames" got really utilized. But the idea had appeared from the very beginning, as can be seen from the two postulates raised in section 02 of paper [1].

To use the idea consistently, both the *c+v* and *c-v* in the first step should be replaced by *c.* You can also see this point from the velocity combination rule under Special Relativity.

Then, how did this self-contradiction escaped Einstein's mind?

One possibility is that Einstein did not know he had put light into a relative motion. When we are concentrated on a very complicated problem, we tend to ignore the simple stuff.

Another possibility is that Einstein knew he was using the Galilean velocity combination rule, but he had to start with something, and he could fix it after the initial result was obtained. But due to the complexity of the problem, the intended fix was forgotten.

Whatever the reason, out of this inconsistency, the theory of special relativity was born.

Still remember the Twin Paradox we were talking about? Now it is time to lay it to rest. The Twin Paradox is insolvable, as it is rooted in the self-contradiction of Special Relativity.

12. The real puzzle behind Special Relativity

Einstein's idea was probably influenced by his time, when the topic of clock synchronization was very popular. But that cannot explain why Special Relativity was not seriously challenged during the past one hundred years.

About light, there is a big puzzle. If this puzzle is not solved, the problem of Special Relativity probably cannot be easily settled down.

In the time of Newton, light was thought to be composed of tiny particles. Later through double-slit experiments, light was discovered to be a kind of wave. And after Maxwell united all the electromagnetic formulas into one theory, light became an electromagnetic wave in a special range.

As all other types of waves are propagated in some media, light should have some medium too. So a stationary aether (or ether) was thought to be that medium, and all celestial bodies run through it. To detect the relative motion between this medium and the Earth, the Michelson-Morley experiment was designed. Because none such relative motion was detected, this experiment went down into history as the most famous failed experiment, and the idea of aether was gradually forgotten.

Actually, the Michelson-Morley experiment did not prove that aether does not exist. If the Earth carries everybody of us, carries the thin air, why does it refuse to carry the aether? If the Earth is carrying the aether, how can we find a relative motion between them?

When talking about the universe, some authors compare the stars and planets to the dust in the air. Taking the fact that the closest star beside the Sun is several light years away from us, we can see that description is not an exaggeration.

The Sun has been sending out light since its birth, so does all the other stars in the universe. Where did all the light go? Maybe a tiny fraction was absorbed by the celestial bodies, but most of them just got lost in the vast space. Does not this lost light form a natural medium for light?

The constant propagation speed of light can be best explained by the vibration of the medium. Among all the tiny particles, like atoms, neutrons, protons, and electrons, which of them always run at the same speed? If light is composed of photons, why are photons so special and always run at the same constant speed? Does not the existence of a medium relieve the photons from such a difficult duty?

Suppose the medium of light does exist, then the postulate about light in Special Relativity will be much easier to understand. It is this medium that decides whether a reference frame is stationary or not.

Does the existence of the medium of light give Special Relativity any validity? Let's go to the next section and see.

13. Special Relativity demystified

In a smooth running river, a gentleman is swimming. As this is his first time of swimming in a river, to make it safe, he is swimming along one bank of the river. He has started from a downstream point A, and intends to reach an upstream point B, and then returns to point A.

Here is the question: What is his average speed during this round trip, if his swimming speed in still water is c, and the river is running downstream at a speed of v?

It is easy to get the average speed, as can be seen from the following:

Time from A to B: $$t_{AB} = \frac{s}{c - v}$$

Time from B to A: $$t_{BA} = \frac{s}{c + v}$$

Total time: $$t_{sum} = t_{AB} + t_{BA} = \frac{s}{c-v} + \frac{s}{c+v} = 2s\left(\frac{c}{c^2 - v^2}\right)$$

Average speed: $$c_{avg} = \frac{2s}{t_{sum}} = \frac{c^2 - v^2}{c} = c\left(1 - \frac{v^2}{c^2}\right)$$

We can see that the average speed is lower than the swimmer's speed in still water.

But unfortunately, this gentleman is no other person than your boss. He is so confident with his swimming skills, if you are to tell him that his speed is less than *c*, you will certainly get yourself into trouble. So you have to tell him that something is wrong with the clock or the ruler, and ask him to try again after you have fixed it.

How should you fix it?

Mathematically, there are numerous solutions available; but physically, you have only three options: using a slower clock, using a shorter ruler, or changing both the clock and the ruler.

Solution 1: A Slower Clock

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

Solution 2: A Shorter Ruler

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

Solution 3: A Slower Clock and a Shorter Ruler

$$t_{fix} = 1/\sqrt{\left(1 - v^2/c^2\right)}$$

$$l_{fix} = \sqrt{\left(1 - v^2/c^2\right)}$$

With all these solutions, there are some common problems.

Problem 1: The solution will get broken if $v \geq c$.

Anyway, the boss will know by his own experience that going upstream is not possible, so the fix is not needed any more.

Problem 2: The solution only works for round trips along the bank.

For one way trip when the direction of *c* and *v* are along the same line, v^2 and c^2 will not appear.

Problem 3: The solution is direction related.

Our example is only a special case, as Galilean velocity addition is actually vector addition. When the path is in an angle of θ (a value between 0 and 90°) with the bank, the average speed can be calculated this way:

$$v_{avg} = c\frac{1-\gamma^2}{\sqrt{1-\sin\theta\cdot\gamma^2}}, \quad \text{where} \quad \gamma = v/c,$$

Let θ=0, we have $v_{avg} = c(1-\gamma^2)$, this is our case.

Let θ=90°, we have $v_{avg} = c\sqrt{1-\gamma^2}$, this is the case when the path is perpendicular to the bank.

Any other angle between 0 and 90° will result in an average speed between these two values. The process leading to this formula is omitted, as it is against our purpose of make things simpler.

Replace the boss with a water wave with re-bouncing capability, the results will not be affected in any way.

Does solution 3 look familiar? The formulas are exactly the same as those of Special Relativity.

How are the formulas obtained?

First, we assumed the swimmer's motion is relative, that is where the $c+v$ and $c-v$ comes from. Then, we assumed the swimmer's speed in moving water is the same as in still water, in another word, the swimmer's motion is an absolute motion.

That is exactly the path taken by Einstein in his paper.

With this knowledge in mind, it is easy to see that the light clocks used in the introductory books on Special Relativity are all fake ones. The light beam of a correctly mounted light clock should be parallel to the spaceship's direction of movement. The authors took the 90° case just because of its similarity in mathematical form, but ignored the fact that Special Relativity is a fix for both time and length at the same time.

In our example here, the broken formula does not mean that the river is not allowed to run faster than the swimmer. It only represents the fact that in the case of $v \geq c$, the swimmer will never have a chance to reach upstream. Because an average speed can not be obtained, any effort trying to adjust this average speed to c is certainly to fail.

Due to the same reason, Special Relativity does not imply that the speed of light is the speed limit in the universe, even if Special Relativity is correct.

14. Some extra thoughts

This section is not about Special Relativity itself, but about its adoption.

There are many kinds of natural clocks, like the day, month, and year. There are also many kinds of man-made clocks, like mechanical, crystal and atomic clocks.

Among all these clocks, which of them runs like a light clock, using the mechanism of a round trip on a straight line? Does this specialty of light clocks makes them better than other types of clocks?

Even if it has been agreed that light clocks are the best, we are still left with one big difficulty. Among all the light clocks, each pointing in a different direction, which one's time should we trust?

How do we understand our world?

By discovering new facts, by explaining unexplained facts, by giving better explanations to explained facts. And the best path leading to understanding is simplicity.

In the Earth-centered view of the universe, a planet's motion has to be explained by two circles. First, the planet is orbiting the Earth in a big circle; at the same time, it is also running in another small circle of its own. Only in this way, the observed retrograde motion of a planet can be explained.

In Copernicus's Sun-centered view, all planets are orbiting the sun, and the retrograde motions of other planets are the natural result of the difference in orbits and periods between the Earth and the other planets.

In his theory of gravity and laws of motion, Newton explained the Moon's movement and the falling of an apple using the same unified view.

We now know that the Sun is not the center of the universe, and maybe the theory of gravity needs to be improved. But no one can disagree that Copernicus and Newton have given us a much simplified view of the universe.

Let us return to our topic here. How does the adoption of Special Relativity can help us understand the universe?

If we have to twist our mind to try to understand, blur our vision to try to see, shouldn't that remind us that the destination is still far away, or even worse, maybe we are going in the wrong direction?

References:

[1]. Albert Einstein, Annalen der Physik, (1905), page 891, **On the Electrodynamics of Moving Bodies**. English translation by George Barker Jeffery. Article from Fourmilab Switzerland.

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