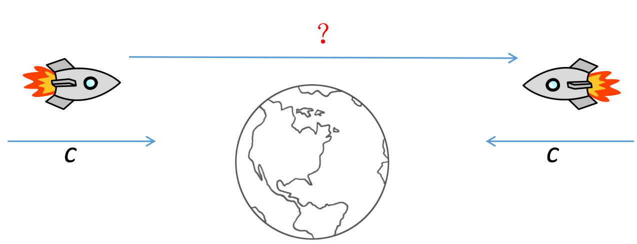
Special Relativity

Baolu Jiang

2018

01. Why is Special Relativity Wrong?

The relative speed between spaceships



Two spaceships are approaching the Earth, both at the speed of light, from opposite directions. What is the relative speed between them?

Two different formulas

Using the normal formula, we get *2c.*

$$u = v + w$$

Using the formula from Special Relativity, we get *c.*

$$u = \frac{v + w}{1 + vw / c^2}$$

Which one is correct?

Two contradicting answers cannot both be correct!

Here are all the possible situations:

	Normal Formula	Special Relativity's Formula	Special Relativity
Case 1	Wrong	Wrong	Wrong
Case 2	Correct	Wrong	Wrong
Case 3	Wrong	Correct	Correct?

Special Relativity can not be correct

Why cannot Special Relativity be correct under case 3?

Special Relativity started from the normal formula:

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

If the normal velocity transformation formula is wrong, the *c-v and c+v* in the above equation must be wrong, then the base of Special Relativity is gone.

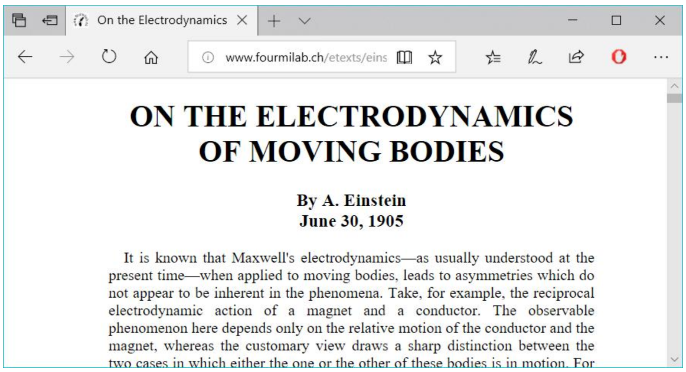
Summary

Why is Special Relativity wrong?

Because Special Relativity started with the normal velocity transformation formula, but got an incompatible formula, thus destroyed its own mathemetical basis.

*Reference

[1] “On the electrodynamics of moving bodies” , Einstein, 1905, http://www.fourmilab.ch/etexts/einstein/specrel/www/



ON THE ELECTRODYNAMICS OF MOVING BODIES

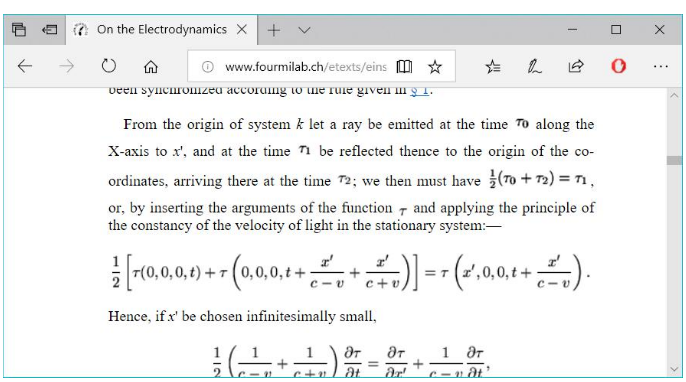
By A. Einstein
June 30, 1905

It is known that Maxwell's electrodynamics—as usually understood at the present time—when applied to moving bodies, leads to asymmetries which do not appear to be inherent in the phenomena. Take, for example, the reciprocal electrodynamic action of a magnet and a conductor. The observable phenomenon here depends only on the relative motion of the conductor and the magnet, whereas the customary view draws a sharp distinction between the two cases in which either the one or the other of these bodies is in motion. For

*Reference

[1] “On the electrodynamics of moving bodies” , Einstein, 1905, http://www.fourmilab.ch/etexts/einstein/specrel/www/

The start equation is from section 3, part I:



been synchronized according to the rule given in § 1.

From the origin of system k let a ray be emitted at the time τ_0 along the X-axis to x', and at the time τ_1 be reflected thence to the origin of the co-ordinates, arriving there at the time τ_2; we then must have $\frac{1}{2}(\tau_0+\tau_2)=\tau_1$, or, by inserting the arguments of the function τ and applying the principle of the constancy of the velocity of light in the stationary system:—

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

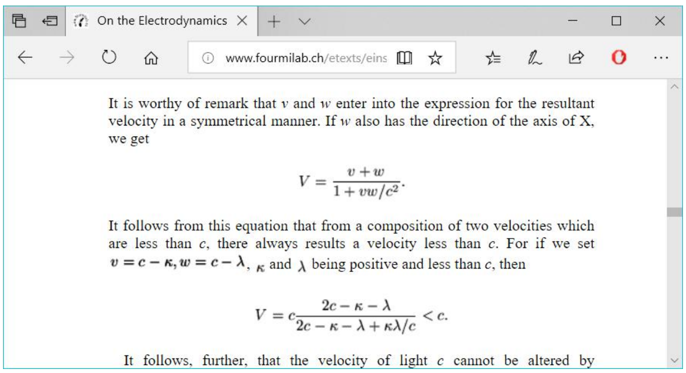
Hence, if x' be chosen infinitesimally small,

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

*Reference

[1] “On the electrodynamics of moving bodies” , Einstein, 1905, http://www.fourmilab.ch/etexts/einstein/specrel/www/

The velocity transformation formula is from section 5, part I:



It is worthy of remark that v and w enter into the expression for the resultant velocity in a symmetrical manner. If w also has the direction of the axis of X, we get

$$V = \frac{v+w}{1+vw/c^2}.$$

It follows from this equation that from a composition of two velocities which are less than c, there always results a velocity less than c. For if we set $v = c - \kappa, w = c - \lambda$, κ and λ being positive and less than c, then

$$V = c\frac{2c-\kappa-\lambda}{2c-\kappa-\lambda+\kappa\lambda/c} < c.$$

It follows, further, that the velocity of light c cannot be altered by

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02. What is Special Relativity?

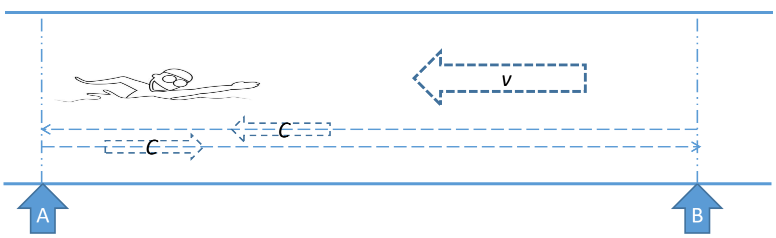
Content

- We will not talk about
  - Time Dilation
  - Length Contraction
- We will
  - Show you the essence of Special Relativity, using only the simple concepts of relative motion and average speed.

A problem of relative speed

A swimmer is swimming in the river. He wants to swim upstream from point A to point B, then swim back.

If his speed in still water is c, and the speed of the river water is v, what is the average speed of his round-trip?



Average speed < C

Suppose the distance between A and B is *s*, then

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

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

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

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

The average speed is less than *c*, the speed of the swimmer in still water.

Trouble！

Unfortunately, this swimmer is no other person than your boss.

He is very confident with his swimming skills. If you say his average speed is less than c, you will certainly get yourself into trouble. So you tell him that something is wrong with the clock or the ruler, and ask him to try again after you have fixed it.

But how to fix it?

Some Fixes

In order to change $c(1\text{-}v^2/c^2)$ to c， you can do one of the following:

use a slower clock, use a shorter ruler, or change both a little bit.

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

$$t_{fix} = 1/\sqrt{1 - v^2/c^2}$$

$$l_{fix} = \sqrt{1 - v^2/c^2}$$

Here the t_{fix} and l_{fix} are the rate by which the clock and ruler are to be changed.

Coincidence?

Do the formulas in solution 3 look familiar?

Do they remind you of something about Special Relativity?

It seems our clock fixing formula in solution 3 and the time dilation formula in Special Relativity look very alike.

$$t_{fix} = 1\Big/\sqrt{1 - v^2 / c^2} \qquad\qquad \tau = t\sqrt{1 - v^2 / c^2}$$

Acutally, our slower clock gives exactly the smaller reading of time needed in Special Relativity.

Is this a coincidence? Absolutely not!

How did our formulas come out?

First, we assumed the swimmer's motion is relative, and let him do a round trip along the bank, that is why the c-v and c+v are there.

Then, we assumed the swimmer's motion is absolute. That is to say, whether relative to the bank or to the river water, the swimmer's speed is always *c.*

In the end, to make up the diffence between the average speed in relative motion and in absolute motion, we have no choice but to make the clock slower or make the ruler shorter.

Special Relativity did the same thing

Just replace the swimmer with a beam of light, our illustration works exactly the same for Special Relativity.

First, Einstein assumed light's motion is relative, and let light do a round trip along the x axises of the reference frames, that is where the c-v and c+v in his first equation came from.

Then, he assumed that light's motion is absolute. That is to say, light moves at the same speed *c* in all reference frames.

To compensate for the speed loss caused by relative motion, the observed distance and time were adjusted.

Why do we have several solutions?

Why is Special Relativity's solution unique, while we have several solutions?

Speed=Distance/Time. To get a bigger speed, we can make the distance bigger, or make the time smaller. Mathematically, we have one equation with two variables, which has numerous solutions. To get a unique solution, one other restriction is needed.

For each of our three solutions, we added another restriction: keep the distance unchanged, keep the time unchanged, or change both by the same extent.

The other restriction used by Special Relativity is the clock synchronization mechanism, which is proposed by Einstein.

Summary

What is Special Relativity?

Special Relativity is an effort trying to build a bridge between relative motion and absolute motion.

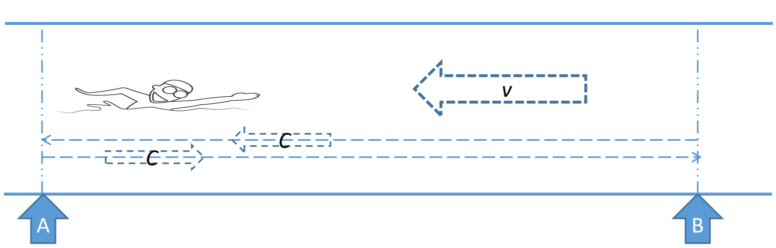
There are numerous "solutions" for such effort.

To make a smaller speed bigger, you have to make the time smaller, or distance bigger, that's the cause of "time dilation" and "length contraction".

*The meaning of the start equation:

half of round trip time=upstream time (how about downstream time?)

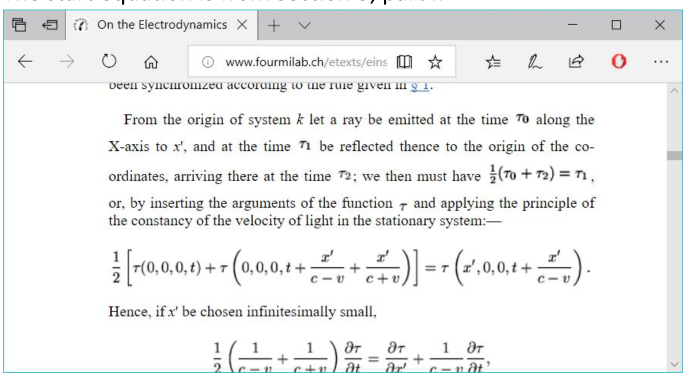
$$\frac{1}{2}\left[\tau(0,0,0,t)+\tau\left(0,0,0,t+\frac{x'}{c-v}+\frac{x'}{c+v}\right)\right]=\tau\left(x',0,0,t+\frac{x'}{c-v}\right)$$



*Reference

[1] “On the electrodynamics of moving bodies” , Einstein, 1905, http://www.fourmilab.ch/etexts/einstein/specrel/www/

The start equation is from section 3, part I:



been synchronized according to the rule given in § 1.

From the origin of system k let a ray be emitted at the time τ_0 along the X-axis to x', and at the time τ_1 be reflected thence to the origin of the co-ordinates, arriving there at the time τ_2; we then must have $\frac{1}{2}(\tau_0+\tau_2)=\tau_1$, or, by inserting the arguments of the function τ and applying the principle of the constancy of the velocity of light in the stationary system:—

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

Hence, if x' be chosen infinitesimally small,

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

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03. The First Postulate

The two postulates

Here are the two postulates of Special Relativity:

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.**

Unless specifically pointed out, all reference frames used here are inertial, meaning that they are either at rest or in uniform motion.

Three sections for two postulates

As there are many things to go over, we will split the content into 3 sections:

- The first postulate
- The second postulate
- The cause of the self-contradiction

We'll talk about the first postulate in this section.

The first postulate

Here is the first postulate:

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.

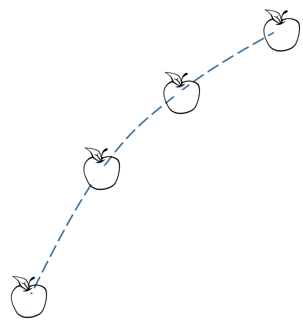
Some questions

- Does this claim have any supporting evidence?
- Can we represent this claim in mathematical form?
- Which physical law is related to reference frames?

The trace of a falling apple

How does its trace look like, when an apple is falling from a tree?

Viewed beside the tree



Viewed from a moving train

The traces vs. the first postulate

Q: The two different traces of the apple seem to contradict the first postulate, how do you explain it?

A: Maybe the first postulate is not about the motion itself.

Q: If it is not about motion, then what are the reference frames for?

A: Maybe we can try the acceleration. Through calculation, the two observers get exactly the same number. So the first postulate is not about the motion itself, but about the cause behind the motion.

Q: In which phycical law does the acceleration appear?

A: In Newton's second law of motion.

Newton's second law of motion

Newton's second law of motion has all the necessary properties to verify the first postulate:

- ➢ It is a physical law
- ➢ It has a mathematical representation
- ➢ It uses acceleration, thus is linked to reference frames

All we have to do, is to prove that it really supports the first postulate.

Verification scenario

In one reference frame, an experiment about Newton's second law of motion is undergoing.

What we have to prove, is that when observed from two different reference frames, the formula **F=ma** works the same way.

Since both reference frames are virtual, they have no effect on **F** and **m**, so we only have to prove that the acceleration in both reference frames are the same.

** We have a section dedicated to the discussion about mass.*

Verification process

In reference frame A, the acceleration is:

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

In reference frame B, the acceleration is:

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

Here v_{AB} is the reference frame A's speed relative to B. Because both reference frames are inertial, v_{AB} does not change with time, so its change rate with time is 0.

Thus, we have proved that the acceleration from both A and B are really the same.

Conclusion from the verification

In the above verification, we used the normal velocity transformation formula:

$$v_B = v_A + v_{AB}$$

This is the concept of relative motion, in its mathematical form.

So a hidden assumption behind the first postulate is, **all objects follow the rule of relative motion.**

Summary

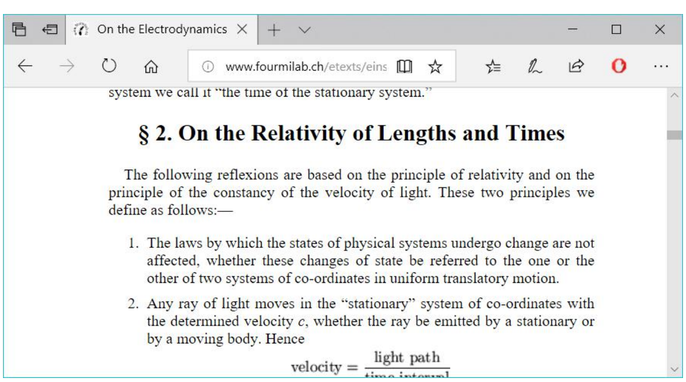
Bringing its hidden assumption to the front, the first postulate becomes:

- Physical laws behave the same in all inertial reference frames
- All objects follow the rules of relative motion.

*Reference

[1] "On the electrodynamics of moving bodies" , Einstein, 1905, http://www.fourmilab.ch/etexts/einstein/specrel/www/

The two postulates are from section 2, part I:



system we call it "the time of the stationary system."

§ 2. On the Relativity of Lengths and Times

The following reflexions are based on the principle of relativity and on the principle of the constancy of the velocity of light. These two principles we define as follows:—

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. Hence

$$\text{velocity} = \frac{\text{light path}}{\text{time interval}}$$

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04. The Second Postulate

Several Questions

Here is the second postulate:

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.

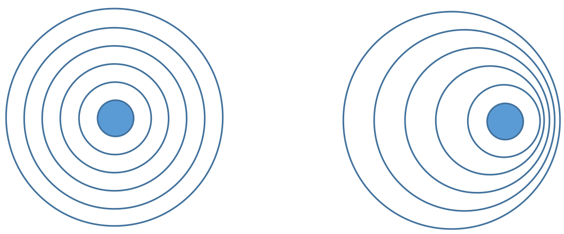
Questions:

- Is the speed of the light source irrelevant?
- Which reference frame is "stationary"?

Source Irrelevant

The speed of wave is not affected by the motion of the source.

As light is a kind of wave, the same should be true for light.



Source is at rest   Source is moving

About "Stationary"

Q: Which reference frame is stationary?

A: There is no stationary reference frame.

Q: When talking about the motion of the light source, which reference frame are we using?

A: If light has a medium, then this medium is our reference frame. If light does not have a medium, then I do not know.

Q: Then how do we understand the second postulate?

A: Let's ask Einstein.

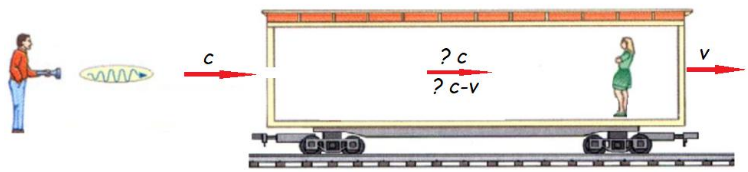
Einstein's explanation

In “Relativity: The Special and General Theory”, Albert Einstein explained it 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.



The second postulate in Einstein's eyes

In the reasoning of Einstein, the sole purpose of a stationary reference frame is to provide a speed for light, so that we can use this speed in all reference frames. That is why the word “stationary” is quoted.

Under this reasoning, the second postulate becomes:

Light travels at the same speed in all reference frames, whether the light source is moving or not.

Einstein's reasoning is wrong

Here Einstein's reasoning is wrong, because he uses the first postulate the opposite way.

The first postulate implies that all motions are relative.

The observed speed c-v is the direct result of the first postulate, while the same speed in all reference frames is against the first postulate.

Summary

Einstein used the first postulate the opposite way, so in his eyes, the second postulate becomes:

Light travels at the same speed in all reference frames, whether the light source is moving or not.

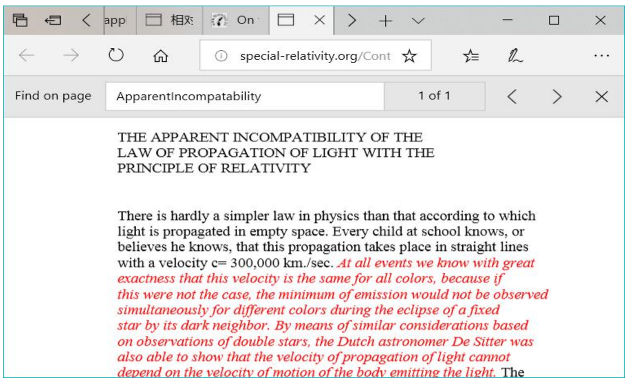
* Many people take this explanation as the second postulate.

* We will continue the discussion in the next section.

*Reference

http://special-relativity.org/Content/Relativity-The-Special-and-General-Theory.pdf

It is from gutenberg project, and the screenshot is from section 07, part I:



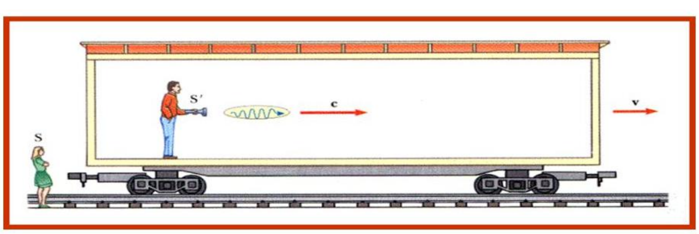
THE APPARENT INCOMPATIBILITY OF THE LAW OF PROPAGATION OF LIGHT WITH THE PRINCIPLE OF RELATIVITY

There is hardly a simpler law in physics than that according to which light is propagated in empty space. Every child at school knows, or believes he knows, that this propagation takes place in straight lines with a velocity c= 300,000 km./sec. *At all events we know with great exactness that this velocity is the same for all colors, because if this were not the case, the minimum of emission would not be observed simultaneously for different colors during the eclipse of a fixed star by its dark neighbor. By means of similar considerations based on observations of double stars, the Dutch astronomer De Sitter was also able to show that the velocity of propagation of light cannot depend on the velocity of motion of the body emitting the light.* The

*Reference

Our image on page 5 is adapted from

https://slideplayer.com/slide/8214763/ (Slide 4), which is about “Special Theory of Relativity” by Donald George, 2016.



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05. The Cause of Contradiction

Questions about light

- Does the propagation of light need media or not?
- Is the motion of light relative or absolute?
- How do we interpret the result of the Michelson-Morley experiment ?

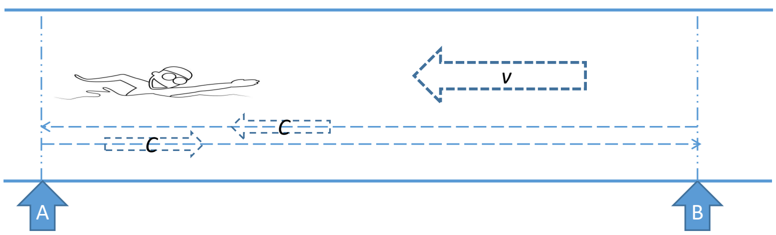
These problems are not easy to answer.

Luckily, to disapprove Special Relativity, we do not need to answer any of them.

Relative motion again

The concept of relative motion is the key to our problem!

The swimmer's speed has several readings. Relative to the water, it is ***c***; but relative to the bank, it is ***c-v*** when going upstream and is ***c+v*** when going downstream. These different speeds are the mathematical representations of relative motion.



Light started from relative motion

If light travels at the same speed in all reference frames, you can never see light's speed as ***c-v*** or ***c+v***, no matter which reference frame you are in.

So the first equation of Special Relativity is about relative motion:

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

Light ended with absolute motion

Halfway in Einstein's paper, the motion of light became absolute, as can be seen from the middle part of section 3, part I:

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.**

Conflicting requirements

The motion of light might be relative or absolute, but **can never be both.**

Since its contradicting requirements can never be met, the theory of Special Relativity must be wrong.

Summary

Special Relativity is the result of these two errors:

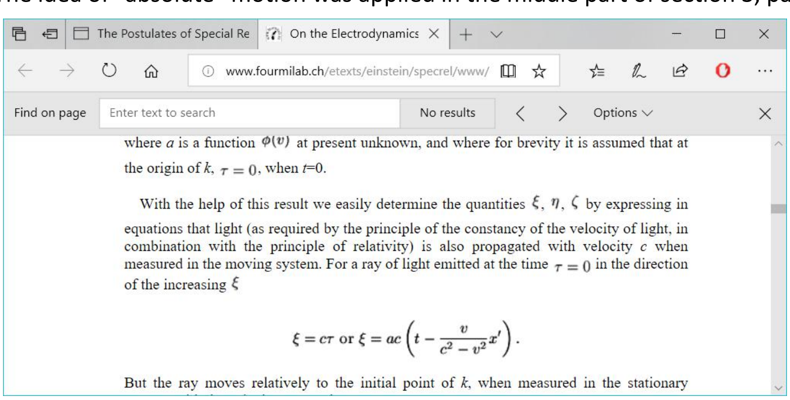
1. Due to his wrong understanding of the first postulate, Einstein obtained the conclusion that “light travels at the same speed in all reference frames”.

2. And to make things worse, the above idea was not followed through. As a result, in Special Relativity, light had to start with a relative motion and end with an absolute motion. This explains why Special Relativity is self-contradicting.

*Reference

http://www.fourmilab.ch/etexts/einstein/specrel/www/

The idea of “absolute” motion was applied in the middle part of section 3, part I:



where a is a function $\phi(v)$ at present unknown, and where for brevity it is assumed that at the origin of k, $\tau = 0$, when t=0.

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

$$\xi = c\tau \text{ or } \xi = ac\left(t - \frac{v}{c^2 - v^2}x'\right).$$

But the ray moves relatively to the initial point of k, when measured in the stationary

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06. About Mass

Problem!

You certainly have noticed one problem:

To verify the first postulate, we assumed that the mass in F=ma is the same in all reference frames, which contradicts the conclusion of Special Relativity.

How can we disapprove Special Relativity using the Newtonian view?

Does mass change?

Does mass change?

My opinion is, the mass of an object might be related to its environment, but this has nothing to do with an observer's reference frame.

But whether mass changes or not is not our focus here.

What we will do next, is to show that in the handling of mass, the Newtonian system is consistent, while Special Relativity is not.

The foundation of the first postulate

Where does the first postulate come from?

As the first postulate covers all physical laws, it can only come from induction.

Here is the general process of induction:

We see one pig is black, another pig is also black, all pigs we have ever seen are all black, so we conclude that all pigs are black.

The first postulate has to start from somewhere.

Through the example of the falling apple, we know Newton's second law of motion is one supporting evidence of the first postulate.

F=ma in Special Relativity

Put Newton's second law of motion $F = ma = m\frac{dv}{dt}$

into two reference frames, we get: $m_A \frac{dv_A}{dt_A} = m_B \frac{dv_B}{dt_B}$

Under Special Relativity, the length, time, and mass all changes with reference frames, so the above equation can not be simplified any further.

F=ma in Newtonian system

In Newtonian system, the length, time, and mass are the same in all reference frames, so $m_A \frac{dv_A}{dt_A} = m_B \frac{dv_B}{dt_B}$

becomes: $\frac{dv_A}{dt} = \frac{dv_B}{dt}$

By Integration, we get: $v_A = v_B + w$

This is the normal velocity transformation formula.

So, in Newtonian system, the first postulate and the normal velocity transformation formula are the same thing.

The complete form of F=ma

The complete form of F=ma is: $F = \frac{d(mv)}{dt}$

Put it in two reference frames, it becomes: $\frac{d(m_A v_A)}{dt_A} = \frac{d(m_B v_B)}{dt_B}$

Under Special Relativity, this is the final form, as nothing can be simplified.

As mass is a constant in the Newtonian system, we can move it out, so the complete form becomes the normal form:

$$F = \frac{d(mv)}{dt} = m\frac{dv}{dt} = ma$$

So our aforementioned conclusions still hold.

Our conclusion

1: **In Newtonian system, the constant mass and the rule of relative motion goes hand in hand with the first postulate.**

2: **Under Special Relativity, the correct application of the first postulate must have mass included.**

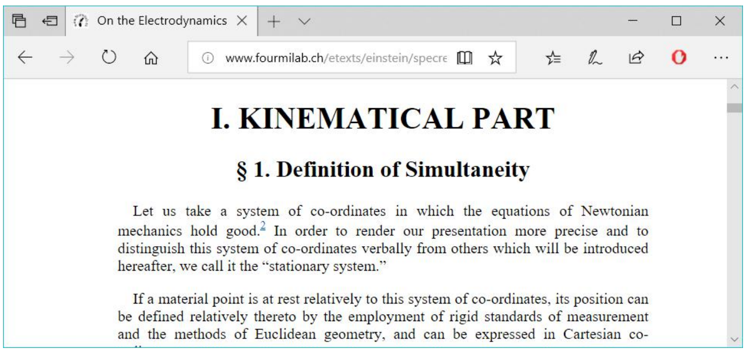
Mass did not appear in the introduction of the theory, (the part about mass was added after Special Relativity was born), so Special Relativity violated the first postulate from the very beginning.

A more specific point is, the conclusion that "light moves at the same speed in all reference frames" is groundless.

*Reference

http://www.fourmilab.ch/etexts/einstein/specrel/www/

The introduction of Special Relativity is in part I:



I. KINEMATICAL PART

§ 1. Definition of Simultaneity

Let us take a system of co-ordinates in which the equations of Newtonian mechanics hold good.[2] In order to render our presentation more precise and to distinguish this system of co-ordinates verbally from others which will be introduced hereafter, we call it the "stationary system."

If a material point is at rest relatively to this system of co-ordinates, its position can be defined relatively thereto by the employment of rigid standards of measurement and the methods of Euclidean geometry, and can be expressed in Cartesian co-

Special Relativity

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07. Summary

Why is Special Relativity wrong?

Special Relativity started from the normal velocity transformation formula, and got an incompatible formula, thus destroyed its own mathematical basis.

What is Special Relativity?

Special Relativity is an effort trying to build a bridge between relative motion and absolute motion.

There are numerous “solutions” for such effort, Special Relative is just one of them.

To make a smaller speed bigger, you can use a slower clock or a shorter ruler. That is where the time dilation and length contraction come from.

The first postulate

The first postulate of Special Relativity is:

Any physical law is not affected by the observer's reference frame.

In the Newtonian system, the first postulate and the normal velocity transformation formula are the same thing.

In plain words, all motions are relative.

The second postulate

The second postulate of Special Relativity is:

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.

But in Einstein's reasoning, the second postulate becomes:

Light travels at the same speed in all reference frames, whether the light source is moving or not.

The cause of self-contradiction

Special Relativity requires the motion of light to be both relative and absolute.

No matter how special it is, light can never meet these two conflicting requirements of Special Relativity.

That is why Special Relativity is self-contradicting.

About Mass

We do not know whether mass changes or not.

But in the handling of mass, the Newtonian system is consistent, while Special Relativity is not.

*References

1. Einstein's paper of Special Relativity
   - “On the Electrodynamics of Moving Bodies”: http://www.fourmilab.ch/etexts/einstein/specrel/www/
2. Einstein's explanation of relativity
   - “Relativity: The Special and General Theory”: http://special-relativity.org/Content/Relativity-The-Special-and-General-Theory.pdf

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