Einstein's and Galilei's Principle of Relativity

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Abstract - The Special Relativity Theory (SRT) proposed by Einstein in 1905, is based on two presumptions: the first one, labelled by Einstein as the Principle of Relativity (PoR), and the second one defining the supposed property of the speed of light in vacuum. This article shows how close Einstein, as well as Lorentz, has been to a solid solution of the problems physicists encountered a century ago, observing electro-magnetic phenomena. It also shows that Einstein's PoR is a fundamentally restricted version of the "now-a-days-PoR".

1. Introduction

The so-called negative result of the experiment of Michelson and Morley urged physicists a century ago to find a solution for the fundamental problem showing up by that result. The Special Relativity Theory emerged as a presumed answer to the problem. In order to try to understand the foundation of this theory, some text written by Einstein has been analysed in detail in this article. Doing so, it turned out that it is also important to show some text of Lorentz, written in the year before Einstein presented his article about SRT.

2. The distinction between axiom, postulate, hypothesis and theorem

The common property of the first three concepts is that they all express a presumption.
There are as many definitions of these three concepts as there are users of them. For that reason it is considered necessary to show the definitions meant in this article.

-An axiom is a presumption of which its validity is strongly self-evident.
-A postulate is a presumption considered valid as long as it has not been proven to be invalid.
-A hypothesis is a presumption of which it is required that its validity has yet to be proven.
-A theorem is a logical result of presumptions of whatever kind.

3. Historical review

The historical review concerns a description, by Lorentz in 1904, of the problems regarding the ether model in relation to the velocity of light, copied in appendix I from reference [1] and a copy of a part of the beginnings of Einstein's translated article: On the electrodynamics of moving bodies, originally written in 1905. See appendix II.

Appendix I shows that Lorentz must have been looking for a postulate, he called it a fundamental assumption, that would lead to the result: "*……. that many electromagnetic actions are entirely independent of the motion of the system."* (Reference [3] shows that Lorentz was searching for evidence of an absolute frame of reference.) Strange however that he would already have been satisfied if only many, so not all, "*electromagnetic actions"* would be "*independent of the motion of the system"*.
That does of course raise the question which actions would have to be excluded and why.
Appendix II shows that Einstein's word 'Vermutung' has been translated into 'conjecture' and his word 'Voraussetzung' into 'postulate'. Most likely Einstein (indeed) meant with his word 'Voraussetzung' a presumption, considered valid as long as it has not been proven to be invalid, here defined as postulate.
Besides these two German words Einstein also used the word "Prinzip", of course translated as "principle". The end of Appendix II shows that Einstein should have used the word "postulate", where he used the word "principle". "Principle" can hardly be distinguished from "axiom".

The most important, (at least in the opinion of the author,) conclusion that can be drawn from Appendix II is that Einstein's postulate, named Principle of Relativity (PoR), is not equivalent to the "now-a-days" postulate, also named Principle of Relativity.
This postulate (or should it be qualified as an axiom?) sounds:

Each physical law is the same in any inertial system.

This results in the conclusion that:

Each experiment carried out in any inertial system shows the same result.

Einstein's PoR is a fundamentally restricted version of the now-a-days one: it (only) states that in case of two arbitrary inertial systems, *moving w.r.t. each other*, it will not make any difference whether the coordinates of the one or the other system are taken as reference for the description of those physical laws that describe the mutual interactions of the physical processes in these two inertial systems. Copied from [2]:

"*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 electro-dynamic 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.* "

We now can conclude:

- that it was Einstein who introduced the postulate named 'Principle of Relativity',
- that he used the word "relativity", in order to express the mutual interaction of physical processes in two arbitrary inertial systems moving *relative* to each other,
- that he wanted to express too, by choosing the word *relative,* that a frame of reference in *absolute* rest had to be rejected,
- that his PoR is a fundamentally restricted version of the "now-a-days PoR",
- that the name of the "now-a-days PoR" should therefore not be Principle of Relativity.

As a result it is proposed to qualify:

Each physical law is the same in any inertial system

as an axiom and to name it:

Principle of Galilean Relativity

meant to express the relativity that originally has been proposed by Galileo Galilei and to honour him posthumously for this extraordinary important axiom.

The applied abbreviation for this axiom in this article will be **PGR**.

Reference [4] shows:
"Galileo put forward the basic principle of relativity, that the laws of physics are the same in any system that is moving at a constant speed in a straight line, regardless of its particular speed or direction. Hence, there is no absolute motion or absolute rest. This principle provided the basic framework for Newton's laws of motion", but presents a fundamental error by adding: "and is central to Einstein's special theory of relativity.", as has been shown above.

4. Einstein's postulate regarding the speed of light

As shown in Appendix II, Einstein proposed the following postulate regarding the property of the speed of light:

> "*Any ray of light moves in the "stationary" system of co-ordinates with the determined speed **c**, whether the ray be emitted by a stationary or by a moving body*."

Einstein's mathematical relations between time, distance and speed of light show his perception of the property of the speed of light in the following situation. A light ray moves in the "stationary" system with speed ***c*** in the direction of a moving rod r_{AB} (with speed v w.r.t. that "stationary" system) passing the one end point A of the rod at t_A, reflected at the other end point B of the rod at t_B and again passing A at t'_A. It shows that the speed of light is taken ***c***-v w.r.t. the rod on the way out and ***c***+v w.r.t. the rod on the way back.

$$t_B - t_A = r_{AB} / (\boldsymbol{c} - v) \qquad \text{and} \qquad t'_A - t_B = r_{AB} / (\boldsymbol{c} + v)$$

The fundamental error in Einstein's second postulate is that he effectively reintroduced with his "stationary" system the ether model, most likely without noticing it, because he rejected the ether model himself in the same article. It is generally accepted that an absolute stationary system does not exist. As a result only a stationary system *w.r.t. another system* can exist. As a consequence that other system is also stationary w.r.t. the first mentioned one. Therefore the introduction of a "stationary" system is senseless, whether it is put in quotes or not. Einstein even defined it as **the** "stationary" system:

> *"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."(Note 2: i.e. to the first approximation.)"*

Regarding this definition it might be that Einstein (only) meant 'inertial system'. However, there are two reasons to reject that possibility. In the above quoted postulate Einstein clearly means 'not moving' with 'stationary': ".....emitted by a stationary or by a moving body". Secondly, the equation $t'_A - t_B = r_{AB} / (\boldsymbol{c} + v)$ shows that after reflection (at point B of the rod) the speed w.r.t. Einstein's "stationary" system is indeed still supposed to be ***c***, notwithstanding the situation that the propagation direction is reversed and the reflector is moving with speed v w.r.t. that "stationary" system.
The ether model prescribed such a property too, and Michelson and Morley based their experiment on this supposed property: the ether determines the speed of light, not the source or reflector! So Einstein indeed effectively reintroduced an ether-like model with the introduction of his "stationary" system.

This fundamental error could have been the main reason for the fact that the community of physicists changed Einstein's postulate to: *the speed of light is c w.r.t. whatever reference,* clearly in contradiction with his postulate and with his two equations shown above. That same community however did not change Einstein's theoretical considerations.
Given the PGR, both postulates can be proven to be incorrect.

5. Theorem Concerning the Reference for c

Based on the PGR, the following theorem can be built up regarding the speed of light:

-The emission of light by a source is based on certain physical laws.
-The speed of light in free space as well as in a tangible medium can be calculated by means of the Maxwell equations.
-Due to the fact that these equations do not show any relation with the source, the calculation of the speed of light in a tangible medium must only concern the situation

that the source is in rest w.r.t. that medium. As a result this speed is referenced to the source as well as to the medium.

-Replacing the tangible medium by free space eliminates the last mentioned reference. What is left is that the speed of light in free space is ***c*** w.r.t. its source.

-The PGR now forces us to conclude that in all inertial systems in free space the speed of light, emitted by a source fixed in that system, is ***c***.

Formulated in a shorter way:
A light source in free space emits light with propagation speed ***c*** *w.r.t. that source.*

Due to the fact that a reflection is, just like an emission, a physical process, the mentioned theory is also applicable in case of a reflector.

In case the light source/reflector is not an inertial system itself, the theorem has to be changed to: the speed of light in free space is ***c*** w.r.t. its source/reflector, *at the moment of emission/reflection*.

6. Einstein's perception regarding the Phenomenon of 'Time'

Einstein's perception of time was developed from the point of view of his definition of simultaneity. This definition forced him to introduce different times in different inertial systems. Most likely as a result, he did not introduce a formal hypothesis about 'time'.

The PGR applied to atomic clocks operating in inertial systems leads to the following consideration:

-Atomic clocks measure time, based on certain physical laws.

-The PGR thus prescribes that atomic clocks in principle measure the same time in all inertial systems.

-SRT claims that atomic clocks will not measure the same time in inertial systems with mutual different velocities.

-SRT thus contradicts the PGR regarding the time transformation as function of speed.

In general: the PGR forces us to conclude that time is universal!
So, all experiments that claim to support time dilation, must have been carried out incorrectly, or interpreted incorrectly, or both.

7. The mysterious observer in SRT

Einstein's idea behind the phenomenon observer is that he created the solution to the following theoretical "problem": how can we *observe/measure* the simultaneity of events, applying light signals?
Einstein created two fundamental problems, putting forward the alleged importance of simultaneity.

-There is no simultaneity problem at all: now here equals now there, wherever 'there' might be, and independent of speed too, as proven above.

-Einstein ignored pure physics by not carefully distinguishing between Theory on the one hand and Measurement on the other hand.

A theory, by definition, does not rely on measurement. A physical theory describes what happens physically. The measurement of what physically happens is a fundamentally different thing. Several measurements have been carried out in order to verify a theory. Verifying the validity of SRT would, regarding the alleged importance of the observer, for example, mean: measure the observation of some mysterious observer, observing the time measurement of two clocks, moving with mutual different speed.
The ridiculousness of such a verification process is self-evident.

8. Einstein's mathematical manipulation

By manipulating his mathematics at a certain point, Einstein succeeded in presenting consistent transformation formulas. 'Consistent' regarding the property of these formulas that, after transforming the coordinates x and t from system S to System S', the original coordinates in S are found again applying the same formulas with the appropriate variables.
This manipulation concerns the variable x, being a constant in S at the start of his mathematics, defined as x=ct at the point of manipulation and again as constant after that.
Without this manipulation he would not have succeeded in realising these 'consistent' transformation formulas.
So, in his heart, Einstein must have known that his assertion below was fanfaronade:

> "those who claim to be able to prove experimentally that SRT is invalid, carried out and/or interpreted their experiment wrongly",

The truth is found by changing the word 'invalid' in 'valid'.

9. Speed of light in a moving medium

Speaking about a moving medium requires in the first place the definition of the reference of the speed of that medium. The most logical reference is the source of the light of which we want to determine the propagation speed. Secondly it is necessary to define the reference for this speed of light. That can be its source, but also the (moving) medium.

In 1818 Fresnel deduced the mathematical expression for the speed of light in a moving medium. His expression shows the so-called drag coefficient of Fresnel. He deduced this expression, assuming that the 'medium' ether was necessary for the propagation of light and at the same time being an absolute reference for whatever velocity. Fizeau experimentally proved the correctness of this expression in 1851:

$c_m' = c_m + v(n^2 - 1)/n^2$

If, instead of what Fresnel assumed, not the ether is taken as the reference for all mentioned velocities, but the source of the light, then this equation has to be interpreted with the following definitions:

- v = the speed of the medium w.r.t. the source of the light, positive in the propagation direction of the light
- n = the refractive index of the medium
- c_m = $\boldsymbol{c}$/n the speed of light w.r.t. its source for v=0
- $\boldsymbol{c}$ = the speed of the light w.r.t. its source in vacuum
- c_m' = the speed of light w.r.t. its source for v not equal zero

Most likely the expression of Fresnel never has been subject of discussion after the medium ether had been abandoned. So be it. By defining the source as the reference for the speed of light and for the velocity of the medium, Fresnel's expression can, without any restriction, be maintained.
As the expression shows: for vacuum (n=1) yields: $c_m' = c_m = \boldsymbol{c}$, the speed of the light w.r.t. its source!
Astronomical light entering the atmosphere of our earth does have a speed, w.r.t. the atmosphere/earth, of say $\boldsymbol{c}+v_{ri}$. The speed v_{ri} represents in first instance, which means at the moment of emission, the mutual speed between the earth and the celestial object at the mentioned moment, an arbitrary time ago. At the moment of receipt the earth is in an arbitrary position in its orbit around the sun and thus has an arbitrary speed compared to the moment of emission. The speed v_{ri} thus is at the moment of receipt v_{rr}. So, in general v_{rr} is (completely) unknown. However this speed equals the v in the above shown expression of Fresnel.
The refraction index n in this situation is not uniquely defined, because it starts with a value very close to 1 and it is about 1.0003 near the surface of the earth. But the final so- called drag coefficient of Fresnel $(n^2 - 1)/n^2$ is of course determined by the refractive index in the neighbourhood of the receiver on earth.

Conclusions

1 In the development of his SRT, Einstein used velocities larger than ***c***, clearly in contradiction with his own conclusion that there are no velocities larger than ***c***.
2 Einstein's postulate regarding the reference for the speed of light in vacuum has been rejected by the community of physicists and replaced by the postulate clearly in contradiction with the one of Einstein.
3 It is proven that neither the one nor the other postulate regarding the speed of light is correct, by showing the *theorem* that the speed of light can only be ***c*** w.r.t. its source (*at the moment of emission* in case the source is not an inertial system).
4 Time must be the same in all inertial systems, based on the Principle of Absolute Relativity: each physical law is the same in whatever inertial system.
5 The phenomenon 'observer', as introduced by Einstein in his SRT, has been proven to be a self-evident ridiculous phenomenon.
6 Einstein built in a mathematical error that strongly gives the impression of a mathematical manipulation.
7 As a result the Special Relativity Theory is an untenable theory.
8 The introduction of the theorem that the speed of light in vacuum is ***c*** w.r.t. its source does not have any influence on the expression of Fresnel, showing the speed of light in a medium moving w.r.t. the source.

References

[1] Electromagnetic phenomena in a system moving with any velocity smaller than that of light, Prof. H. A. Lorentz, Proceedings of the Royal Netherlands Academy of Arts and Sciences, 1904, 6: 809–831. Copy of original text found at: http://www.dwc.knaw.nl/DL/publications/PU00014148.pdf

[2] Translated original article of Einstein:
On the electrodynamics of moving bodies, By A. Einstein, June 30, 1905
To be found at: http://www.fourmilab.ch/etexts/einstein/specrel/www/

[3] https://en.wikipedia.org/wiki/Lorentz_ether_theory

[4] https://en.wikipedia.org/wiki/Galileo_Galilei

Appendix I

Lorentz's opinion about the consequences of the negative result of M & M's experiment.

As shown in [1] Lorentz wrote in 1904:

"*§ 2. The experiments of which I have spoken are not the only reason for which a new examination of the problems connected with the motion of the Earth is desirable.*
POINCARÉ [4]) has objected to the existing theory of electric and optical phenomena in moving bodies that, in order to explain MICHELSONS's negative result, the introduction of a new hypothesis has been required, and that the same necessity may occur each time new facts will be brought to light. Surely, this course of inventing special hypotheses for each new experimental result is somewhat artificial. It would be more satisfactory, if it were possible to show, by means of certain fundamental assumptions, and without neglecting terms of one order of magnitude or another, that many electromagnetic actions are entirely independent of the motion of the system. Some years ago, I have already sought to frame a theory of this kind. I believe now to be able to treat the subject with a better result. The only restriction as regards the velocity will be that it be smaller than that of light."

Appendix II

Einstein's opinion about the consequences of the negative result of M & M's experiment.

As shown in [2] Einstein wrote in 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 electro-dynamic 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 if the magnet is in motion and the conductor at rest, there arises in the neighbourhood of the magnet an electric field with a certain definite energy, producing*

a current at the places where parts of the conductor are situated. But if the magnet is stationary and the conductor in motion, no electric field arises in the neighbourhood of the magnet. In the conductor, however, we find an electromotive force, to which in itself there is no corresponding energy, but which gives rise—assuming equality of relative motion in the two cases discussed—to electric currents of the same path and intensity as those produced by the electric forces in the former case.

Examples of this sort, together with the unsuccessful attempts to discover any motion of the earth relatively to the "light medium," suggest that the phenomena of electrodynamics as well as of mechanics possess no properties corresponding to the idea of absolute rest. They suggest rather that, as has already been shown to the first order of small quantities, the same laws of electrodynamics and optics will be valid for all frames of reference for which the equations of mechanics hold good. We will raise this conjecture (the purport of which will hereafter be called the "Principle of Relativity") to the status of a postulate, and also introduce another postulate, which is only apparently irreconcilable with the former, namely, that light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body. These two postulates suffice for the attainment of a simple and consistent theory of the electro-dynamics of moving bodies based on Maxwell's theory for stationary bodies. The introduction of a "luminiferous ether" will prove to be superfluous inasmuch as the view here to be developed will not require an "absolutely stationary space" provided with special properties, nor assign a velocity-vector to a point of the empty space in which electromagnetic processes take place."

Two pages further:

*"**§ 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."