Parameterized Special Theory of Relativity (PSTR)

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We have parameterized Einstein's thought experiment with atomic clocks, supposing that we knew neither if the space and time are relative or absolute, nor if the speed of light was ultimate speed or not. We have obtained a Parameterized Special Theory of Relativity (PSTR) (1982). Our PSTR generalized not only Einstein's Special Theory of Relativity, but also our Absolute Theory of Relativity, and introduced three more possible Relativities to be studied in the future. After the 2011 CERN's superluminal neutrino experiments, we recall our ideas and invite researchers to deepen the study of PSTR, ATR, and check the three new mathematically emerged Relativities 4.3, 4.4, and 4.5.

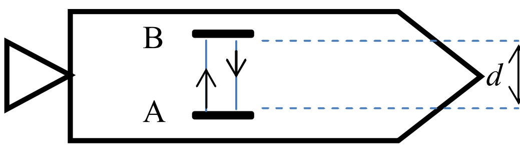
Keywords: Special Theory of Relativity, Absolute Theory of Relativity, Parameterized Relativity, Thought Experiments

1. Einstein's Thought Experiment with the Light Clocks.

There are two identical clocks, one is placed aboard of a rocket, which travels at a constant speed v relative to the earth, and the second one is on earth. In the rocket, a light pulse is emitted by a source from A to a mirror B that reflects it back to A where it is detected. The rocket's movement and the light pulse's movement are orthogonal. There is an observer in the rocket (the astronaut) and an observer on the earth. The trajectory of light pulse (and implicitly the distance traveled by the light pulse), the elapsed time it needs to travel this distance, and the speed of the light pulse at which is travels are perceived differently by the two observers {depending on the theories used – see below in this book}.

According to the astronaut:

Fig. 1



$$\Delta t' = \frac{2d}{c} \tag{1}$$

where:

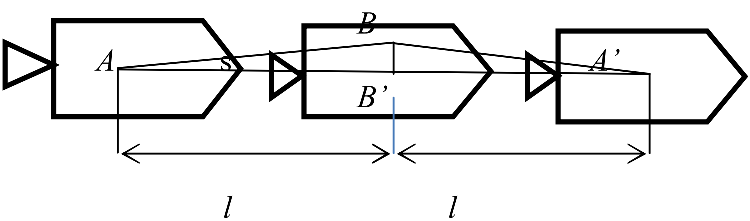
$\Delta t'$ = time interval, as measured by the astronaut, for the light to follow the path of distance $2d$;

d = distance;

c = speed of light.

According to the observer on earth:

Fig. 2



$$2l = v \cdot \Delta t \tag{2}$$

$$s = |AB| = |BA'| \tag{3}$$

$$d = |BB'| \tag{4}$$

$$l = |AB'| = |B'A'| \tag{5}$$

where Δt = time interval as measured by the observer on earth. And using the Pythagoras' Theorem in the right triangle $\Delta ABB'$, one has

$$2s = 2\sqrt{d^2 + l^2} = 2\sqrt{d^2 + \left(\frac{v \cdot \Delta t}{2}\right)^2} \tag{6}$$

but $2s = c \cdot \Delta t$, whence

$$c \cdot \Delta t = 2\sqrt{d^2 + \left(\frac{v \cdot \Delta t}{2}\right)^2} \tag{7}$$

Squaring and computing for Δt one gets:

$$\Delta t = \frac{2d}{c} \cdot \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{8}$$

Whence Einstein gets the following time dilation:

$$\Delta t = \frac{\Delta t'}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{9}$$

where $\Delta t > \Delta t'$.

2. Parameterized Special Theory of Relativity (PSTR)

In a more general case when we don't know the speed x of the light as seen by the observer on earth, nor the relationship between $\Delta t'$ and Δt, we get:

$$x\Delta t = 2\sqrt{d^2 + \left(\frac{v\Delta t}{2}\right)^2} \tag{10}$$

But $d = \dfrac{c\Delta t'}{2}$, therefore:

$$x\Delta t = 2\sqrt{\left(\frac{c\Delta t'}{2}\right)^2 + \left(\frac{v\Delta t}{2}\right)^2} \tag{11}$$

Or

$$x\Delta t = \sqrt{c^2\left(\Delta t'\right)^2 + v^2\left(\Delta t\right)^2} \tag{12}$$

Dividing the whole equality by Δt we obtain:

$$x = \sqrt{v^2 + c^2\left(\frac{\Delta t'}{\Delta t}\right)^2} \tag{13}$$

which is the **PSTR Equation**.

3. PSTR Elapsed Time Ratio τ (Parameter).

We now substitute in (10) for a general case

$$\frac{\Delta t'}{\Delta t} = \tau \in (0, +\infty) \tag{14}$$

where τ is the PSTR Elapsed Time Ratio.

Therefore we split the Special Theory of Relativity (STR) in the below ways.

4. PSTR Extends STR, ATR, and Introduces Three More Relativities.

4.1. If $\tau = \sqrt{1-\frac{v^2}{c^2}}$, i.e. Lorentz's factor, we get the STR (see [1]), since

replacing x by c, one has

$$c^2 = v^2 + c^2\left(\frac{\Delta t'}{\Delta t}\right)^2,$$

$$\frac{c^2}{c^2} - \frac{v^2}{c^2} = \left(\frac{\Delta t'}{\Delta t}\right)^2,$$

or

$$\frac{\Delta t'}{\Delta t} = \sqrt{1-\frac{v^2}{c^2}} \in [0,1]$$ as in the STR.

4.2.If $\tau=1$, we get our Absolute Theory of Relativity (see [2]) in the particular case when the two trajectory speed vectors are perpendicular, i.e.

$$x = \sqrt{v^2 + c^2} = |\vec{v} + \vec{c}|.$$

4.3.If $0<\tau<\sqrt{1-\frac{v^2}{c^2}}$, the time dilation is increased with respect to that of the STR, therefore the speed *x* as seen by the observer on earth is decreased (becomes subluminal) while in STR it is *c*.

4.4.If $\sqrt{1-\frac{v^2}{c^2}}<\tau<1$ there is still time dilation, but less than STR's time dilation, yet the speed *x* as seen by the observer on earth becomes superluminal (yet less than in our Absolute Theory of Relativity). About superluminal velocities see [3] and [4].

4.5.If $\tau>1$, we get an opposite time dilation (i.e. $\Delta t'>\Delta t$) with respect to the STR (instead of $\Delta t'<\Delta t$), and the speed *x* as seen by the observer on earth increases even more than in our ATR.

Further Research

The reader might be interested in studying these new Relativities mathematically resulted from the above 4.3, 4.4, and 4.5 cases.

References

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