Henk Druiven, August 27, 2019 – Alternative Bigbang Theory

The special theory of relativity for dummies.

If an object moves in relation to a (non-accelerating) observer, Einstein has taught us that the time of the object **t'** differs from the time **t** of the observer, and in such a way that

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

Einstein deduced this by saying that the speed of light is the same for everyone and everything.

The comparison can also be written differently as:

$t'^2 = t^2 - \frac{s^2}{c^2}$ or $t^2 = t'^2 + \frac{s^2}{c^2}$. $\frac{s}{c}$ is the distance expressed in light seconds.

The nice thing about this comparison is that it doesn't matter in which direction the object is moving, as long as the speed is constant.

An example:

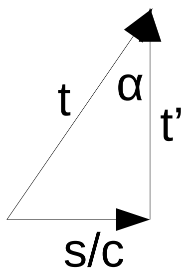
> Suppose we shoot a clock at an enormous speed to Mars and back again at the same speed.
> Mars is at that moment 180 million km (equal to 10 light minutes) away from us (round trip 360 million km is 20 light minutes).
> According to an observer on earth, the clock takes 40 minutes to return. What time shows the clock when it is set to zero on departure?

Answer:

$$t_{clock} = \sqrt{t^2 - \left(\frac{s}{c}\right)^2} = \sqrt{40^2 - 20^2} = 34.64\, min = 34\, min + 38\, sec.$$

In other words: "If an object bridges a certain distance in the inertial system of an observer, the object thereby bridges a certain time."

Graphically you can display this as follows:



s lies in the space dimensions of the observer.

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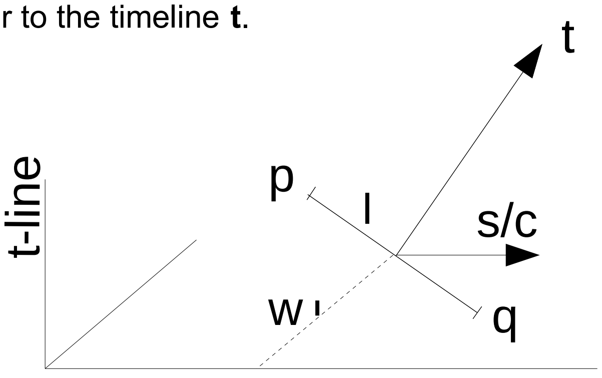
The space dimensions of the object are perpendicular to the timeline **t**.
For the observer this looks like this:

l is the length of the object between **p** and **q**.
For convenience, we delete one of the three space dimensions.

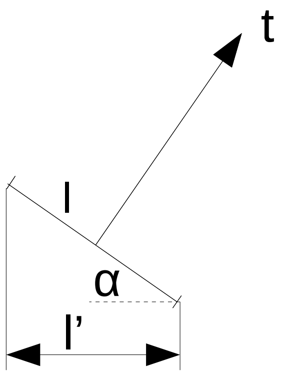


Lorentz-FitzGerald contraction:

For the observer, the length of the object is partly in its space and partly in its time dimension. The observer sees for that reason a shortening of the object, namely the projection of l on the space dimensions of the observer.

$$l' = l . \cos(\alpha) = l \frac{t'}{t} = l \sqrt{1 - \frac{v^2}{c^2}}$$

$\frac{v}{c}$ is the speed expressed in units of c.

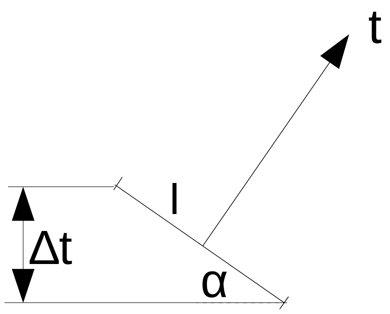


If at **p** and **q** clocks are set up and are synchronized, the observer measures between these two clocks a time difference equal to the projection of **l** on the timeline of the observer.

$$\Delta t = l/c . \sin(\alpha) = l/c . \frac{s/c}{t} = \frac{l}{c} . \frac{v}{c}$$

$\frac{l}{c}$ is the length in light seconds.

$\frac{v}{c}$ is the speed expressed in units of c and is a measure of the redshift.



See also:
[Calculating with relativistic quantities can be a lot easier.]()
[Can anything other than the expansion of the universe explain the redshift?]()