Symmetric Contradiction in Relativity Theory,
the Importance of Velocity Direction,
and Feeling the Earth's Acceleration

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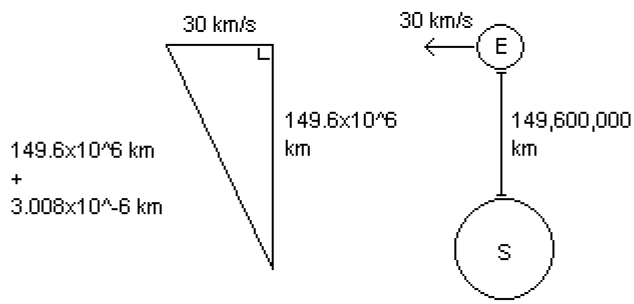
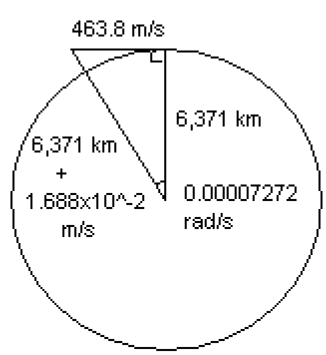
We fall toward the Earth, yet the Earth falls toward the Sun. If the pull toward the Sun is stronger, then why do we fall toward the Earth? The answer is that we all feel an acceleration toward the Earth, but in different amounts at different positions, such that the center of the pull on the Earth is offset by a few millimeters per second from the Earth's center. Thus, we can treat the Earth as a point mass in gravitational calculations.

Why do we not spin off the Earth, if it is rotating at such a high speed? The answer is not simply that we are rotating at a fixed speed along the surface, but that the acceleration required per second to keep us planted on the ground is a mere 1.688 centimeters per second per second.

Given a distance from the Sun of 149,600,000 km and a sideways orbital speed at any given moment of 30 km/s, only a length of 3.008x10^-6 km is needed for the hypotenuse to equal the adjacent arm. That is, Earth is only accelerated toward the Sun at a rate of 3.008 millimeters/seconds^2.



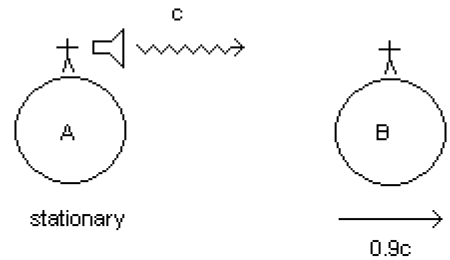
Likewise, given a circumference of 40,075 km, over a single day, gives a surface rotational speed of 0.4638 km/s or 463.8 m/s, in radians being 7.272x10^-5 radians/second (or 0.00007272 radians/second), with an adjacent arm equal to Earth's radius of 6,371 km, gives a hypotenuse only 1.688x10^-2 meters greater than the adjacent arm. That is, only an acceleration of 1.688 centimeters per second per second is required to keep us planted on the ground, which is much less than the experienced gravitational force of 9.8 m/s^2.



This in mind, we can at least say that our feeling of acceleration is absolute. A light traveling a path length of 1 km should at most be offset by 6x10^-7 meters. That is, for a light traveling at c, 300,000 km/s, for 1 second, the Earth relative to it should only experience an acceleration of a few centimeters per second per second at most, and, bringing the path down from a scale of 300,000 to 1 km/s, will bring an acceleration offset of 2 centimeters/seconds^2 down to 0.6 micrometers (or 600 nanometers).

Now let's consider an example from relativity that concerns the speed of light. Two sides adrift in space should not be able to tell apart who is moving relative to whom.

A's point of view

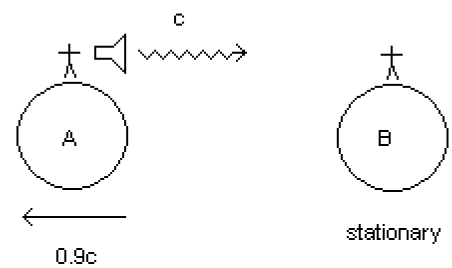


To A, it would appear that the light beam shines at the speed of c, that B is moving away at 0.9c, and that the light is only 0.1c faster than B. [1]

To B, it would seem that A is moving away at the opposite velocity, and that the light is traveling at the full speed of c relative to stationary self.

To explain this, we invoke time dilation, and assume that B's time runs slower than A's, so that in B's shorter second, the light travels a full 1c instead of 0.1c.

B's point of view



According to the Lorentz boost transformation, [3]

$t' = \gamma(t - vx/c^2)$
$x' = \gamma(x - vt)$

$\gamma = 1/\sqrt{(1 - v^2/c^2)}$

Where (ct, x) are the spacetime coordinates of a single event in a frame at rest and (ct', x') are the spacetime coordinates of the same event in a moving frame and v is the relative velocity in the x-direction and c is the speed of light.[3]

Given 1 second of A's time, during which A sees B move at 0.9c, the perceived amount of time that will pass for B is **0.4358** seconds:

t = 1 sec.
v = 0.9c
$\gamma = 1/\sqrt{(1 - v^2/c^2)} = 1/\sqrt{(1 - 0.81)} = 1/\sqrt{0.19} = 1/0.4358 = 2.294$
$x = 0.9c*sec.$
$t' = \gamma(t - vx/c^2) =>$
$t' = 2.294(1 \text{ sec.} - (0.9c)(0.9c*\text{sec.})/c^2) =>$
$t' = 2.294 \text{ sec.}(1 \text{ sec.} - 0.81 \text{ sec.}) =>$
t' = 0.4358 sec.

We will get the same results according to the Lorentz transformation, [2]

$c^2(t_2 - t_1)^2 - (x_2 - x_1)^2 - (y_2 - y_1)^2 - (z_2 - z_1)^2 =$
$c^2(t_2' - t_1')^2 - (x_2' - x_1')^2 - (y_2' - y_1')^2 - (z_2' - z_1')^2$

Or the 1-dimensional form:

$c^2(t_2 - t_1)^2 - (x_2 - x_1)^2 =$
$c^2(t_2' - t_1')^2 - (x_2' - x_1')^2$

Where (ct, x, y, z) are the spacetime coordinates of a single object in frame A and (ct', x', y', z') are the spacetime coordinates of the same object in frame B.[3]

Given 1 second of A's time, during which A sees B move at 0.9c, while B considers itself stationary, the perceived amount of time that will pass for B is 0.4358 seconds:

$t_2 - t_1 = 1$ sec.	(B's time in A's view)
$x_2 - x_1 = 1$ sec * 0.9 c	(B's motion in A's view)
$x_2' - x_1' = 0$	(B's motion in B's view)

$c^2 (1 \text{ sec.})^2 - (1 \text{ sec} * 0.9 c)^2 = c^2(t_2' - t_1')^2 - (0)^2$
$t_2' - t_1' = \sqrt{(1 \text{ sec.}^2 -1 \text{ sec.}^2 * 0.81)} = \sqrt{0.19} = 0.4358$ sec. (B's time in B's view)

Now let's imagine if B moves back at 0.9c to the original position, and let's say that that position is where A is. Then upon reuniting B's clock will only have 0.8716 seconds, while A will have 2.

$t = 1$ sec.
$v = -0.9c$
$\gamma = 1/\sqrt{(1 - v^2/c^2)} = 1/\sqrt{(1 - 0.81)} = 1/\sqrt{0.19} = 1/0.4358 = 2.294$
$\Delta x = -0.9c$
$t' = \gamma(t - vx/c^2) =>$
$t' = 2.294(1 \text{ sec.} - (-0.9c)(-0.9c*\text{sec.})/c^2) =>$
$t' = 2.294 (0.19 \text{ sec.}) =>$
$t' = 0.4358$ sec.

And:

$t_3 - t_2 = 1$ sec.	(B's time in A's view)
$x_3 - x_2 = - 1$ sec * 0.9 c	(B's motion in A's view)
$x_3' - x_2' = 0$	(B's motion in B's view)

$c^2(1 \text{ sec.})^2 - (-1 \text{ sec.} * 0.9 c)^2 = c^2(t_3' - t_2')^2 - (0)^2$
$t_3' - t_2' = \sqrt{(1 \text{ sec.}^2 - 1 \text{ sec.}^2 * 0.81)} = \sqrt{0.19} = 0.4358$ sec. (B's time in B's view)

If instead B experiences length contraction of the world relative to itself:

$t_3 - t_2 = 1$ sec.	(B's time in A's view)
$x_3 - x_2 = - 1$ sec * 0.9 c	(B's motion in A's view)
$t_3' - t_2' = 0.4358$ sec.	(B's time in B's view)

$c^2(1 \text{ sec.})^2 – (- 1 \text{ sec} * 0.9 c)^2 = c^2(0.4358 \text{ sec.})^2 – (x_3' – x_2')^2$
$x_3' – x_2' = \sqrt{((1 \text{ sec.}^2 – 0.81 \text{ sec.}^2 - 0.18992164 \text{ sec.}^2) * c^2)} =$
$\sqrt{(0.00007836)} = 0.008852$ c*sec. (B's motion in B's view)

Still, upon reuniting, according to B, B's clock will only have 0.8716 seconds, while A will have 2.

However, in B's perspective, where B sees A receding at 0.9c in the opposite, for 0.4358 seconds, will give an A time of **0.1899** seconds:

$t_2' – t_1' = 0.4358$ sec. (A's time in B's view)
$x_2 – x_1 = 0$ (A's movement in A's view)
$x_2' – x_1' = - 0.4358 \text{ sec} * 0.9 c$ (A's movement in B's view)

$c^2(t_2 - t_1)^2 – (0)^2 = c^2(0.4358 \text{ sec.})^2 – (- 0.4358 \text{ sec} * 0.9 c)^2$
$t_2 – t_1 = \sqrt{(0.18992164 \text{ sec.}^2 – 0.1538365284 \text{ sec.}^2)} =$
$\sqrt{0.0360851116} = 0.1899608$ sec. (A's time in A's view)

According to the Lorentz inverse boost transformation, [3]

$t = \gamma(t' + vx'/c^2)$
$x = \gamma(x' + vt')$

Then,

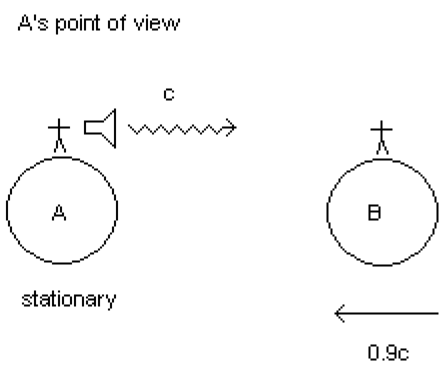
$t' = 0.4358$ sec.
$v = -0.9c$
$\gamma = 1/\sqrt{(1 + v^2/c^2)} = 1/\sqrt{(1 + 0.81)} = 1/\sqrt{1.81} = 1/1.345 = 0.7434$
$\Delta x = -0.9c$
$t = \gamma(t' + vx'/c^2) =>$
$t = 0.7434(0.4358 \text{ sec.} + (-0.9c)(-0.9c*\text{sec.})/c^2) =>$
$t = 0.7434 (1.2458 \text{ sec.}) =>$
$t = 0.9261 \text{ sec.} \sim 1$ sec.

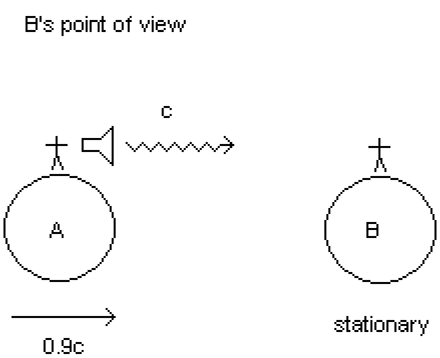
However, even though this is the inverse transformation, and is said to give A's point of view, from B's, we still gained those values originally from A's point of view of B, and we are equally able to say, with negative velocity and negative offset in the forward Lorentz boost transformation, that if B sees A receding at 0.9c, for **1 seconds**, A gives a time of **0.4358** seconds:

$t_2' – t_1' = 1$ sec. (A's time in B's view)
$x_2 – x_1 = 0$ (A's movement in A's view)
$x_2' – x_1' = - 1 \text{ sec} * 0.9 c$ (A's movement in B's view)

$c^2(t_2 - t_1)^2 – (0)^2 = c^2(1 \text{ sec.})^2 – (- 1 \text{ sec} * 0.9 c)^2$
$t_2 – t_1 = \sqrt{(1 \text{ sec.}^2 – 0.81 \text{ sec.}^2)} = \sqrt{0.19} = 0.4358$ sec. (A's time in A's view)

Which is the exact reverse, where B sees A receding at 0.9c, for **1 second**, which will give the opposite situation and a contradiction. Or else, there is a one-sidedness and we must assume that only one side experiences time dilation.





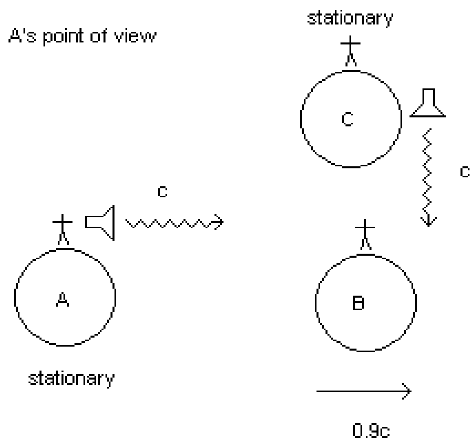
If in the other case B moves inward to the shining light at 0.9c, it would seem to A that the light moves past B at a combined 1.9c.

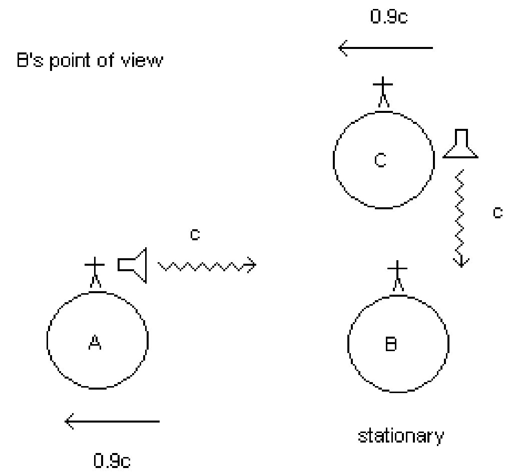
To B, it would seem that the light is only moving 0.1c faster than A is moving closer.

This is explained by length contraction, as B would measure A's length to be shorter so that the combined distance of 1.9c in a second is squished to 1c in a second, and B's speed is thus measured to be slower.

And again, let us consider the situation where B shined a light back at A. Would A then experience the same effect in the other direction? This would appear to indicate that these are one-sided relations and that the velocities must be assumed to be one-sided, or else there is a symmetric contradiction. If either side filmed the other and showed it to them, they would see their relativistic principle violated, or else there must be some other explanation. It is said that both sides would experience time dilation with a relative velocity away from each other, and it would appear to either that time is dilated for the other, which would have to reconcile if they reunited. However, what of the case if both are said to see the other as shorter in the direction of motion. Or if B is shortened, while a third side C passes perpendicular through B, or if a fourth side D is approaching on the X axis, while receding on the Y axis, while remaining stationary on the Z axis. This is all difficult to understand, and which a computer can answer.

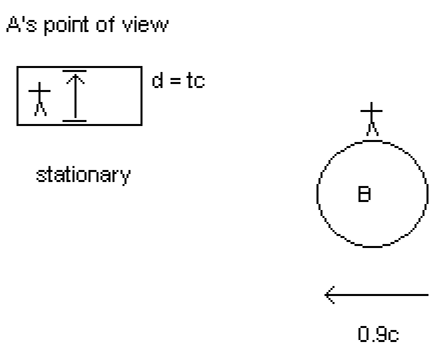
Consider another example, where two perpendicular lights are shined at B. If B's time runs slower to compensate for the relative slowness of light compared to itself from A's perspective, then the light from C must be faster in B's second.

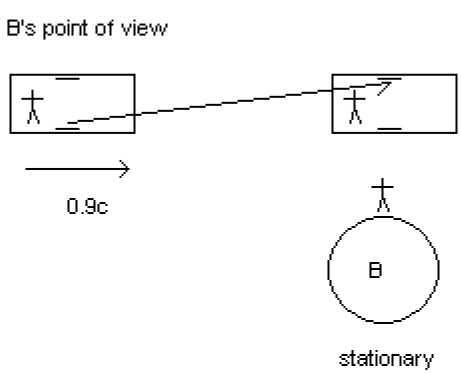


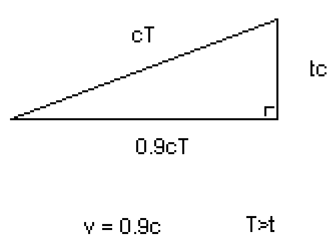


At first glance, time dilation and contraction appeared to be sufficient to explain any situation, even the case where a light is shined from both sides, including perpendicular to each other, and where the three sides move in any direction and relative speed to each other. However, it appears we cannot assume that this can be explained unless there is absolute motion.

Now let's compare this to the example of the train.







It would appear to B that a light beam shined vertically on the sideways-moving train takes a longer path, given its apparent sideways motion, and from this we can construct a Pythagorean triangle, that given B's perceived time T and light speed c, gives t, the other side's perceived time duration. B's exact position is unimportant and it is only the inertia that matters. And from this equation also derives the Lorentz transformation. Given a non-perpendicular light direction compared to the velocity, we can construct a different triangle. However, how can the Lorentz transformation be correct if it is applied to cases where the motion of A in B's perspective is not perpendicular to the direction of light in A's perspective and thus does not give a Pythagorean triangle?

However, this would appear to be in contradiction with time dilation as measured from the previous examples, as the train example appears to show that regardless of the direction away or to B, the train will experience a smaller time interval.

Looking at the equation $(tc)^2 + (vT)^2 = (cT)^2$ by itself seems to say, “Lose some time by gaining some position offset.” Then, if one gains some time, is it everything else moving relative to oneself? And, jokingly, it is not clear whether it is more beneficial to be able to react faster, or to age less.

[1] *Stars, Galaxies & Cosmology.* Bennett, Donahue, Schneider, Voit.
<http://cse.ssl.berkeley.edu/bmendez/ay10/2002/notes/lec11.html>
[2] <https://en.wikipedia.org/wiki/Derivations_of_the_Lorentz_transformations>
[3] <https://en.wikipedia.org/wiki/Lorentz_transformation>
[4] <http://www.physicspages.com/2011/04/06/space-time-intervals/>