(a) Brief explanation of (i) time dilation, (ii) apparent invariance of light speed;
(b) Derivation of the symmetric Lorentz Transformation in the context of a unique static reference frame.

contact

Includes **Everything's symmetrical – apparently** [The Lorentz Transformation]: p. 67

The first half of this chapter, on time dilation and the perceived invariance of the speed of light, first appeared in *Behind the Tapestry: The Threads Revealed*, Transfinite Mind, Feb. 2008 [ISBN: 978-0-9554382-3-3] © G Blackwell 2007

Chapter 5

Transforming the Universe

In this chapter we're going to look at not just one, but two major transformations of our universe.

First we're going to give the cosmos a complete makeover, replacing the universe as it's been understood and taught for the past century with a new one that can be understood a great deal more easily. Not a new *universe*, of course, simply a new understanding of the one that's been around for nearly fourteen billion years.

That new understanding makes very straightforward sense of various things that can otherwise seem pretty puzzling, even mind-bending.

That new understanding can be summed up in just one sentence:

Light behaves the same as everything else in the universe with regard to the issue of speed.

That may not sound very revolutionary. But it is, if anything, even more revolutionary than Einstein's pronouncements at the beginning of the twentieth century on the nature of the cosmos. Because it takes us out of a universe of all sorts of apparent paradoxes – time reversals, different orderings of events, even different distances between the same two points – and puts us straight back into one where times, events, distances all behave themselves and there's a logical cause-and-effect explanation for all of it. Everything is exactly as you would expect it to be.

The second transformation completes the picture. It shows exactly how, given that things are just as you'd expect them to be, it then somehow appears that they're not. It shows how this is an *observer effect*, a consequence of how we and everything else are formed, leading to the subjective impression that it makes no difference what speed you're travelling at.

This leads on, of course, to the fact that it could make all the difference in the world – in the universe – and that recognizing these apparent weirdnesses as observer effects could open up all sorts of amazing new opportunities. Matter, gravity, maybe even space and time themselves, might be amenable to manipulation in all sorts of ways to achieve things we couldn't even imagine without that recognition, that understanding.

Let's start at the very beginning – and I mean the *very* beginning.

<u>Starting with nothing in particular…</u>

Ok, so the Big Bang kicked things off with a massive outpouring of energy – photons. No particles to start with. At that stage the universe was incredibly tiny, about the size of the smallest sub-atomic particle (that didn't yet exist), and in that unbelievably compact bundle of energy those photons would have been forced into all sorts of contortions as well as interacting with all the others around them.

It's not surprising, then, that those shape-shifting photons will have formed just about every configuration imaginable in those first few quintillionths of a second.

So it's also not surprising that a few of them, one in every billion or so, will have gone through a configuration that turned out to be stable, a closed-loop form that withstood the battering of all the other energy blasting around it. Those closed loops, those stable photon structures, are what we now call 'particles'.

Initially of course those first particles were flying around far too fast to join up with each other. But as they spread out, slowed down, cooled a bit, quarks joined up to form protons (and a few neutrons) then they joined up with electrons to form hydrogen atoms (and a few helium atoms).

All of the other types of atoms were formed when vast clouds of these first ones drew together under mutual gravitational attraction; those earliest atoms bonded together under the process known as *nuclear fusion* to form the cores of heavier atoms, at the same time giving out light and heat. The first stars were born.

Right, that's enough on *nucleosynthesis* (creation of atomic nuclei); let's now look at the implications for particles and objects in different states of motion.

We've already seen how the photon energy-flow of a particle in motion is travelling both along and around at the same time and how that reduces the rate of energy flow around the particle, effectively slowing its rate of time-experience. We've also seen how that along-and-around spiral flow of photon energy causes a particle to respond to other objects and energies as if its personal spacetime axes are tilted in the direction of motion.

Both of these effects cause the perception/response of that particle – or an object formed from many such particles – to be distorted accordingly.

We can represent these effects on a simple diagram. Figure 1 shows the sloping spiral energy flow of a particle B moving at speed v: the vertical axis represents the cyclic energy-flow component, which is responsible for time-experience in a particle or object; the horizontal axis represents the linear flow component that gives a particle or object its motion. The sloping spiral energy flow is the combination of those two components.

In the same diagram we have particle A, which is static. This means that its formative energy flow is fully cyclic (shown as vertical) with no linear velocity component; this in turn also means that A will experience time at the full rate, with no motion-based *time dilation*.

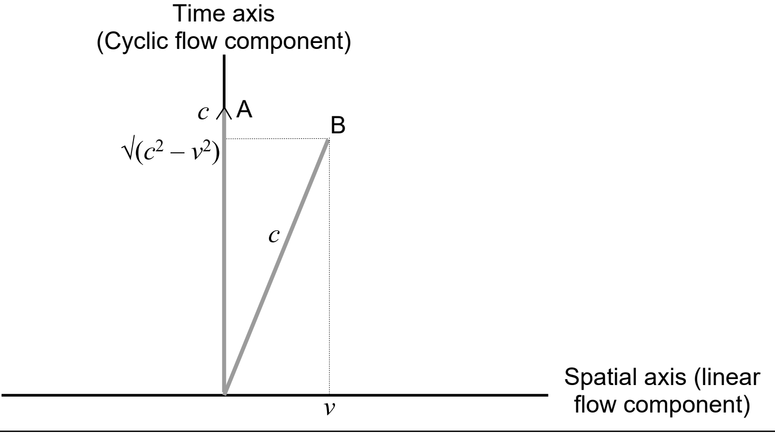


Figure 1
Static particle A with fully cyclic energy flow (shown as vertical) and hence no time dilation; particle B moving at speed v, so tilted energy flow to form spiral in direction of motion. B's cyclic flow speed component is thus reduced, giving time dilation.

In both cases the full energy-flow speed is c, the speed of light. Those familiar with Pythagoras' Theorem will see that the speed of the cyclic component of B's energy flow is $\sqrt{(c^2 - v^2)}$, which is $\sqrt{(1 - v^2/c^2)}$ times the full flow speed c; *i.e.* the time-experience of B is slower than A's time-experience by this factor, which gives the standard *Relativistic time dilation* (stretching) factor of: $1/\sqrt{(1 - v^2/c^2)}$.

We now need to think briefly about what we mean by *relative speed*. If I'm in my car, either static or moving, and another vehicle passes me in either direction I can assess its speed relative to me by considering how quickly the distance between me and that vehicle increases; that's a question of distances and times, and my perception of those distances and times.

But if that vehicle actually collides with my car, the issue is quite different: it's then a matter of how the particles of the other vehicle interact with mine – specifically, how the energy flows of one vehicle's particles interact with those of the other. In this case perceived distances don't come into it at all, it's all down to on-the-spot angles and speeds of energy interactions, and the time-response of the particles involved.

We'll look at that first issue in the next section. Here we're concerned with the actual interaction between two particles – or between a moving particle and light.

In figure 2 an additional axis has been included, showing B's perception of the direction of spatial motion for other objects. Remember that B's experience of other energy flows, either in other particles or linearly as light, is tilted by the slope of its own energy flow (like that man leaning forward who thinks he's standing upright). Here we've removed the static particle A and added another particle C moving in the same direction as B but at a greater speed w.

B experiences C's speed as the projection of C's energy flow onto B's personal 'spatial direction', *i.e.* as the foreshortened measure w'. That will be increased in B's perception by B's own time dilation factor $1/\sqrt{(1 - v^2/c^2)}$.

[When v is a lot smaller than c, w' is pretty much equal to $w - v$, as we'd expect.]

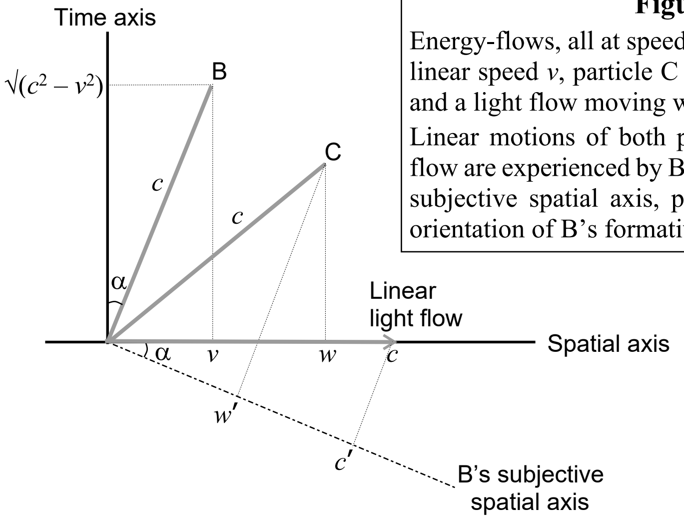


Figure 2

Energy-flows, all at speed c, of particle B moving at linear speed v, particle C moving at linear speed w, and a light flow moving wholly linearly at speed c. Linear motions of both particle C and linear light flow are experienced by B as projected onto B's own subjective spatial axis, perpendicular to the spiral orientation of B's formative cyclic light flow.

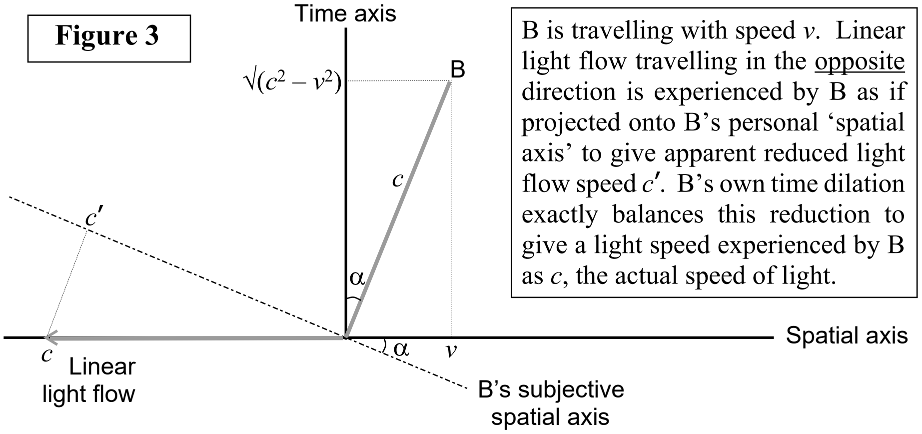
If we now consider a beam of light travelling in the same direction as B, then it will be flowing in the 'linear flow' direction with no cyclic component (which is why, in the conventional view, light experiences no passage of time).

From B's perspective that linear flow direction will be along B's personal 'spatial direction' axis, which is at right angles to B's own energy-flow direction.

So B will experience light as moving along that line – which is at the same angle to the true 'spatial direction' axis as B's own energy-flow line is to the true 'cyclic flow' axis (marked as α in both cases). So the projection of that light onto B's personal 'spatial direction' axis – which is how B will experience it – is reduced by exactly the same factor as B's own time-experience. The speed of that light passing B will appear to be $c' = \sqrt{(c^2 - v^2)}$, but since B's personal time-experience clock is ticking at that same reduced rate then B will experience it as being speed c, the full speed of light.

If we instead consider light moving in the opposite direction to the particle, we'd probably expect the result to be considerably greater – just like two vehicles colliding head-on rather than whilst travelling in the same direction. That's a misperception, though, as we can see from figure 3. The reason for this is that we shouldn't be thinking in terms of 'distances travelled per second' but rather the instantaneous interaction of two energy flows at different angles.

Figure 3



B is travelling with speed v. Linear light flow travelling in the opposite direction is experienced by B as if projected onto B's personal 'spatial axis' to give apparent reduced light flow speed c'. B's own time dilation exactly balances this reduction to give a light speed experienced by B as c, the actual speed of light.

From figure 3 we can immediately see that the projection of this new light flow onto B's personal 'spatial direction' axis is the same as in figure 2, apart from being in the opposite direction (those familiar with the *dot product* of two vectors will see exactly why this is so). If we again apply the time dilation factor for B's reduced clock speed then that projection of $\sqrt{(c^2 - v^2)}$ again becomes c, the full speed of light – no more and no less.

So there's a thing: whether light is coming at a moving object from up ahead or overtaking from behind, that object will experience the light-flow as if it's moving *relative to them* at full light speed, c, no more and no less – even though that's not in fact so. Light is in reality *always* moving at speed c relative to the unique objectively static cosmic state of absolute rest, its *actual* speed relative to a moving object will be the directional sum (or difference) of c in the light's direction and the object's own velocity.

Of course light could approach in any direction – at any angle to the particle's own direction of motion. This same principle still holds but the maths gets a little bit more complicated, so the full proof for all directions of approach is included separately in Appendix B. You'll see there that light flow from *any* angle, projected on to B's subjective 'spatial direction' and adjusted for B's reduced time-perception, *always* comes to that same value, *c*.

In other words, the interaction of a material particle or object with light will be experienced by that particle or object exactly as if it were static and the light was moving relative to the particle/object at its full speed *c* – regardless of the actual speed of the particle/object.

This is the fundamental basis of Relativity Theory: light will be experienced by any object as travelling at its full speed, *c*, relative to that object, irrespective of the object's own speed. It's clear from this analysis that this is due to the light-based structure of all objects rather than some absolute property of light itself.

There are a variety of experiments that appear to provide supporting evidence for that proposed absolute speed of light; we looked briefly at most of those in Chapter 2. In the next chapter we'll see how they can all be readily explained by this new take on interactions between light and matter.

<u>If it's all the same to you…</u>

So might it all be absolutely symmetric? Might it not in fact be the case that A's perception of B and B's perception of A are total mirror-images of each other? If so, maybe it doesn't matter whether we use the conventional Relativity-based view of reality or this one based on the spun-light structure of particles. Maybe all roads lead to Rome, scientifically speaking.

This is actually a very important question. There's absolutely no point in shifting from one scientific paradigm to another if they're actually just different perspectives on the same cosmic reality. In the next section we'll see how the light-formed nature of matter leads to a perception of symmetry, just as proposed by conventional Relativity. But first we'll look at one very simple illustration of how the two theories are incompatible, how spun-light particles naturally lead to an intrinsic asymmetry that's directly contrary to Relativity Theory.

Figure 4 is a repeat of figure 1, in which we have a static particle A and a particle B moving at speed *v*; but we've now included B's subjective personal spatial axis and projected onto it A's apparent motion as experienced by B. From the diagram it's obvious that this projection is the same length as B's actual speed *v* – so it would seem that B's experience of A's apparent motion is indeed equal and opposite to A's experience of B's actual motion.

We haven't yet taken account, though, of B's motion-related time dilation, which means that for B every second lasts longer. This in turn means that the speed *v* marked on B's personal spatial axis will actually appear faster in B's experience. In other words, B's experience of A's (apparent) speed is *not* equal and opposite to A's experience of B's (true) speed.

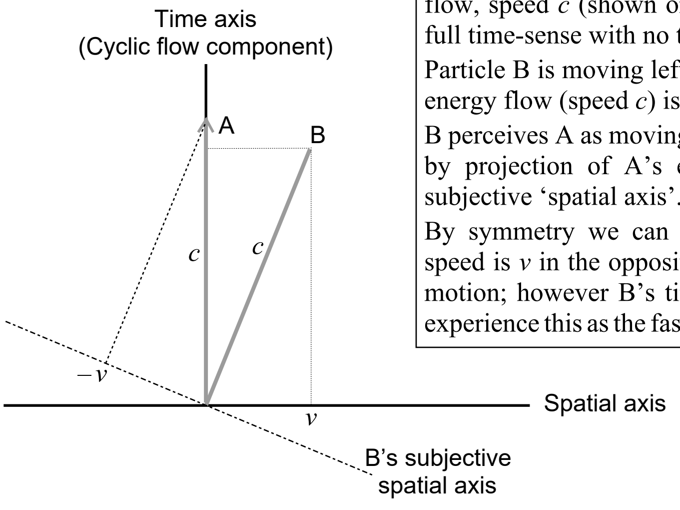


Figure 4

Particle A is static, so with fully cyclic energy flow, speed c (shown on vertical axis), giving full time-sense with no time dilation.

Particle B is moving left-to-right at speed v, so energy flow (speed c) is tilted in that direction.

B perceives A as moving right-to-left as shown by projection of A's energy flow onto B's subjective 'spatial axis'.

By symmetry we can see that A's apparent speed is v in the opposite direction to B's true motion; however B's time dilation leads B to experience this as the faster speed $v/\sqrt{(1-v^2/c^2)}$.

As we'll see shortly, this asymmetry in instantaneous interactions isn't apparent in wider space-time interactions due to compensating factors resulting directly from the perceived invariance of the speed of light. In fact distinctions between the Relativity-based view and the spun-light view only become apparent at the particle-structure level, as in this example.

It's vital, though, to recognise that those distinctions make all the difference in the world (/universe) when it comes to advancing our scientific understanding. For example, the explanation given in Chapter 8 for the underlying principles of gravity wouldn't be possible in the Relativity-based model of the universe. Conversely, the threat to cosmic causality from time-reversal as a result of faster-than-light travel isn't an issue in the description of reality presented here.

More than this, Relativity places serious constraints on the directions in which science may advance, possibly obscuring important truths about the universe. If we're to make the most of all that the universe has to offer, we can't allow ourselves to be limited by unnecessary (imaginary) constraints.

Chapter 9 gives a formal proof of the invalidity of the Principle of Relativity as it's generally interpreted, based exclusively on well-established scientific findings that have in every case merited a Nobel prize.

Everything's symmetrical – apparently [The Lorentz Transformation]

[Advise prior study of Appendices A & B , on time dilation & light speed - found at: https://r.ihs.ac/ab.pdf]

One of the two postulates of Special Relativity is the invariance of the speed of light across all *inertial frames of reference* – constant-velocity states of motion free of gravitational fields. The other, which is inextricably linked to the first, is that the fundamental laws of physics apply identically across all such frames of reference.

These postulates lead to the concept of *frame symmetry*: to see a physical space-time situation from a new perspective you apply a mathematical transformation (set of formulae) to the space and time co-ordinates relating to that situation; to reverse the process you simply apply the *same* transformation in the opposite direction. The two situations are identically matching opposites.

As we've previously seen, this is described in Relativity as a rotation in spacetime: to shift from the perspective of motion-state I to motion-state II you rotate the space-time axes for the given situation a certain amount in the relevant direction; to shift back from II to I you rotate those axes the same amount in the opposite direction. Two totally symmetric perspectives, just rotate spacetime a little to the right or back to the left (metaphorically speaking) to see one or the other.

From the spun-light understanding on matter it's very clear that a static situation - a scientific experiment, for example - and one conducted in a vehicle travelling at a hundred, a thousand, a million miles an hour are *not* identical. The energy flows forming the particles in those different situations will be tracing out quite different paths with potentially different consequences at a fundamental level – notably rates of progress of various processes.

However, as it turns out, transformations from the perspective of one state of motion to another *are* directly reversible in a way that gives the impression that all reference frames *are* symmetric.

The situation as subjectively perceived is shown by the spun-light view of matter to give exactly the impression of symmetry that's proposed as actual fact by Relativity. The distinction between 'actual fact' and 'subjective impression' can't be detected by even the most sophisticated measuring apparatus.

Hendrik Lorentz, who was a close colleague of Einstein's, formulated a set of equations that are now referred to as *The Lorentz Transformation*. These equations define how space and time co-ordinates for objects, positions and events in a given situation are transformed to shift the observer's perspective on that situation from one state of motion to another.

This ability to shift to the perspective of a different motion-state is fundamental to all sorts of issues in particle physics, where conditions relating to particles moving at close to the speed of light need to be taken account of. It's also pretty important in astrophysics, particularly high-energy astrophysics (*high energy* here generally means either 'very high speed' or high-frequency photons, *e.g.* gamma rays).

The Lorentz Transformation defines how new spatial coordinates (x', y', z') and a new time coordinate t' can be calculated from original coordinates (x, y, z) and t, for a new reference frame moving at speed v with respect to the original frame.

In its simplest form the speed of motion is taken to be acting in the x-direction so that only the x and t values change; this means that y' is the same as y and z' is the same as z. That's how we're going to do it here.

The Lorentz Transformation, derived on assumptions of the frame invariance of the speed of light and frame equivalence, is then:

$$x' = \frac{x - vt}{\sqrt{(1 - v^2/c^2)}}$$

$$t' = \frac{t - (v/c^2)\,x}{\sqrt{(1 - v^2/c^2)}}$$

where x and t are distance and time as perceived in the (static) observer frame, *i.e.* from the perspective of a static observer, and x' and t' are distance and time as perceived or measured by an observer moving at speed v relative to that frame. [Having started from a situation where both observers and their clocks are all at the same point and both clocks are set to zero at that point.]

We're going to look at how that transformation works out if we *don't* make those assumptions but just work from the findings of the spun-light view of particles:

(1) light appears from all reference frames to be moving at speed c; and

(2) time dilation for moving objects is as given by Relativity Theory.

If you're ok with a bit of maths (algebraic fractions, mainly) you might like to work through the reasoning below, otherwise you could skip to the end of that (to the line flagged in **bold print**, bottom of page two pages ahead) and compare the results with the Lorentz Transformation above.

To do this we'll need two frames of reference, one static and one moving at speed v in the x-direction (each just one-dimensional as we're only moving in a straight line). We'll follow Einstein's example and use a long straight railway line for a static reference, with a station at one end as our origin.

For the moving reference we'll use a long string of flat-bed trucks pulled by an engine moving at speed v; the origin for our moving reference is a guard's truck bringing up the rear of the line of trucks.

We then need a starting point where the two origins coincide at time zero: we'll get our stationmaster and the guard on the train to both reset their clocks as the guard's truck passes the signal box on the station. We'll also need an event of some sort at time t, a distance x from the signal box – organised in such a way that the guard can work out his/her perception of the timing and distance of that event, t' and x'.

We'll arrange for a light signal to be sent (most appropriately) from the signal box – referred to as S from now on – at a time t_S when the train is a little way down the line. That signal passes the guard's truck – now referred to as G – at time t_G, then travels on down the line to a reflector – R for short – where it's reflected back to reach G again at final time T. R is a distance x from S and the light-signal reaches R at time t – that's the event we're interested in.

A straightforward analysis of this situation is outlined on the following two pages, with reference to a simple diagram.

Figure 5 shows the situation at time t, when the light-signal has just reached R and is being reflected back to G. We need to figure out the guard's perception of the distance from the moving origin, G, to R – that's our x' – and of the time that the signal reaches R – that's our t'. Our derived expressions for x' and t' in terms of x and t will be the equations for transformation from a static frame to a moving frame, as derived from the spun-light structure of matter without any assumptions of absolute properties in respect of the speed of light.

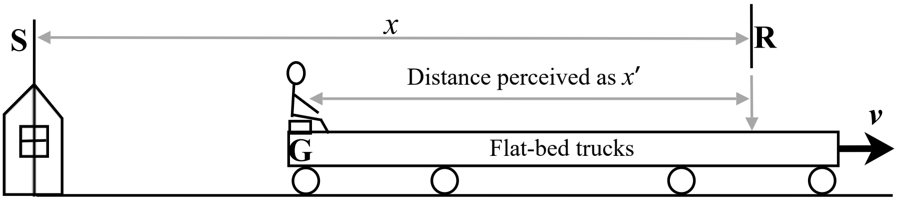


Fig. 5
Trucks travel at speed v along rails with static observer at S. A guard on the trucks at G passes S at time zero. At time t_S a signal is set off at S to reach R at a distance x, at time t, perceived by the guard as t'. The distance to R is perceived by the guard as x'.

First, the time taken by the light-signal to travel at speed c from S to R will of course be x/c. So we can write:

$$t = t_S + x/c \qquad , \quad \text{or} \qquad t_S = t - x/c$$

We can also get an expression for the time t_G at which the signal first arrives at G. This will be the start time for the signal, t_S, plus the time vt_G/c for it to travel at light speed to vt_G, which is of course where G has got to by that time travelling at speed v. So we get:

$$t_G = t_S + vt_G/c \qquad , \quad \text{or} \qquad t_G = t - x/c + vt_G/c$$

This can be rearranged to give t_G in terms of x, v and c to give:

$$t_G = \frac{(ct - x)}{(c - v)}$$

Also, the time T for the light-signal to arrive back at G will be its time of arrival at R, t, plus the time taken for that signal to return to where G now has reached. By that time T, G will have travelled a distance vT, so the return distance for the light-signal will be: $x - vT$. The time taken for that return journey, at light speed, will thus be: $(x - vT)/c$.

From this we get that: $$T = t + \frac{(x - vT)}{c}$$

If we rearrange that equation to give an expression for T in terms of x, v and c, we get:

$$T = \frac{(ct + x)}{(c + v)}$$

So the time taken for the light-signal to get from G to R and back to G is given by:

$$T - t_G = \frac{(ct + x)}{(c + v)} - \frac{(ct - x)}{(c - v)} = \frac{(ct + x)(c - v) - (ct - x)(c + v)}{(c + v)(c - v)}$$

$$= \frac{2c(x - vt)}{(c^2 - v^2)} = \frac{2c(x - vt)}{c^2(1 - v^2/c^2)} = \frac{2(x - vt)}{c(1 - v^2/c^2)}$$

This is the *actual* time for light to travel from G to R and back to G. G's perception is that light is travelling *relative to the train* at the same speed, *c,* in both directions. So G's perception of the time for light travelling one way, from G to R (or R to G) is half of this, multiplied by the inverse time dilation factor for G's slowed time-sense, $\sqrt{(1 - v^2/c^2)}$, as this is how it'll appear on G's clock.

So G's perception of time for light to travel at speed c from G to R is:

$$\frac{(x - vt)}{c(1 - v^2/c^2)} \times \sqrt{(1 - v^2/c^2)} = \frac{(x - vt)}{c\sqrt{(1 - v^2/c^2)}}$$

To find G's perception of the distance from G to R we simply multiply that perceived time for the light-travel by the speed of light (to see how far G reckons the light travelled in that time):

$$x' = \frac{c(x - vt)}{c\sqrt{(1 - v^2/c^2)}} = \frac{(x - vt)}{\sqrt{(1 - v^2/c^2)}}$$

To find t', the time that G perceives that light-signal as arriving at R, we simply deduct G's perception of the time of light-travel G-to-R from G's perception of the final return time, T. Note that G's perception of T is just the actual value of T multiplied by G's time-dilation factor, as read off G's clock that was reset to zero along with the stationmaster's clock right at the beginning of this exercise.

So:

$$t' = \frac{(ct + x)}{(c + v)} \times \sqrt{(1 - v^2/c^2)} - \frac{(x - vt)}{c\sqrt{(1 - v^2/c^2)}}$$

$$= \frac{(ct + x)(c - v)}{(c^2 - v^2)} \times \sqrt{(1 - v^2/c^2)} - \frac{(x - vt)}{c\sqrt{(1 - v^2/c^2)}}$$

$$= \frac{(ct + x)(c - v)}{c^2(1 - v^2/c^2)} \times \sqrt{(1 - v^2/c^2)} - \frac{c(x - vt)}{c^2\sqrt{(1 - v^2/c^2)}}$$

$$= \frac{(ct + x)(c - v) - c(x - vt)}{c^2\sqrt{(1 - v^2/c^2)}} = \frac{(c^2 t - vx)}{c^2\sqrt{(1 - v^2/c^2)}} = \frac{t - (v/c^2)\,x}{\sqrt{(1 - v^2/c^2)}}$$

So we have: $x' = \frac{(x - vt)}{\sqrt{(1 - v^2/c^2)}}$, $y' = y$, $z' = z$, $t' = \frac{t - (v/c^2)\,x}{\sqrt{(1 - v^2/c^2)}}$

exactly as for conventional Relativity.

[But without the need for any unique metaphysical property of light.]

But what if the guard were able to physically measure the distance (s)he reckons to be x'? Wouldn't that give the game away? Wouldn't that make it obvious to them that they're on a moving platform – that their frame of reference *couldn't* be considered as static?

OK, so let's add another small feature to our freight-train scenario. We'll fix it so that at the instant that light signal reaches R, as well as immediately being reflected back towards S it triggers a mechanism that instantaneously sprays a splash of white paint onto the trucks at P.

This means that the guard could, whenever (s)he chooses, take a tape measure or ruler and measure the distance from the back of the train to that mark on the truck that was passing R just as the light got there – the distance perceived as x'.

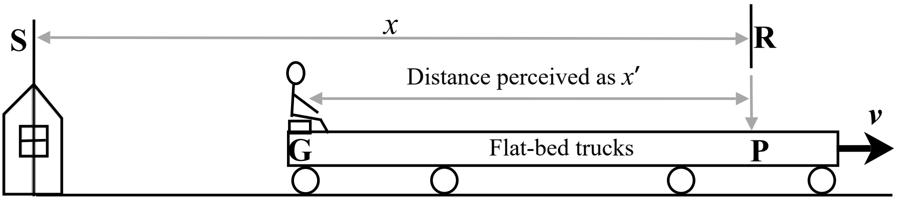


Fig. 6
Scenario exactly as for figure 5, with the addition of a mechanism that marks the train at P, directly adjacent to R, at the instant that the light signal reaches R.

So what would that guard find?

Well, we know that the train has been moving at speed v for time t since the guard's seat G passed the signal-box S (from the perspective of an observer at S), at the instant that paint mark was made at P. This means that the distance from S to G is vt from that static observer's perspective. So the distance that's reckoned by the guard as x' is seen by that observer as $x - vt$ (that's SR - SG).

Now there's substantial research, quite independent of Relativity, indicating that objects physically contract when in a state of motion. Einstein adopted that view as part of his Special Theory of Relativity but it was proposed earlier, separately by three other researchers, as a direct consequence of Maxwell's Equations. [See *Lorentz-FitzGerald Contraction* in the Glossary at the end of this book.]

The factor for this contraction at speed v is – surprise, surprise – $\sqrt{(1 - v^2/c^2)}$. So the guard's tape measure would be contracted by this factor, meaning that any distances measured would appear to be longer by the inverse of that factor (since *e.g.*, a tape contracted by a factor of ¾ would measure 3 metres as 4 metres).

So if the *actual* distance from G to P is $x - vt$, then the guard would measure it as $(x - vt)/\sqrt{(1 - v^2/c^2)}$ – exactly the distance calculated from their observations. This would give the idea (erroneously) that guard and stationmaster's views are indeed equally objective and that light passes each of them at relative speed c.

[Note that contraction of the train itself is included in observer's measurement of x.]

Looking back to the Lorentz Transformation:

$$x' = \frac{(x - vt)}{\sqrt{(1 - v^2/c^2)}}, \quad y' = y, \quad z' = z, \quad t' = \frac{t - (v/c^2)\,x}{\sqrt{(1 - v^2/c^2)}}$$

It's not difficult to rearrange this set of equations to give:

$$x = \frac{(x' + vt')}{\sqrt{(1 - v^2/c^2)}}, \quad y = y', \quad z = z', \quad t = \frac{t' + (v/c^2)\,x'}{\sqrt{(1 - v^2/c^2)}}$$

In other words, to transform x', y', z', t' to x, y, z, t (to move from the new frame back to the original) we apparently simply use the same formulae except with $+v$ in place of $-v$. It appears that the transformation is directly reversible – *i.e.* symmetric.

But is this valid? Is it an acceptable step to simply reverse the sign of v in order to reverse the transformation? This implies that if S measures G's speed as v then G will measure S's (apparent) speed as $-v$. Is this actually so?

Our earlier analysis has already shown that, in an instantaneous interaction between a static particle and a particle in motion, the latter will experience the former as having an apparent speed higher than the moving particle's own actual speed. This won't necessarily apply, though, in relation to assessment of speed based on measurements of times and distances – both of which are subject to motion-related subjective distortion.

We can assess the transformed speed v', the apparent speed of S as measured by G, in two quite different ways. One is to use differentiation (calculus) to derive an expression for the rate of change of distance with time: $v' = dx'/dt'$. The other is to consider a physical scenario, as we have above. [Skip from here to the next **bold print** if you're not into maths.]

To find dx'/dt' we first derive dx'/dt and dt'/dt by differentiating our expressions for x' and t' with respect to t. Then we multiply dx'/dt by dt/dt' (the inverse of dt'/dt) – often referred to as *chain rule*.

If $x' = \frac{(x - vt)}{\sqrt{(1 - v^2/c^2)}}$ [where v and c are constants], then: $dx'/dt = \frac{(dx/dt - v)}{\sqrt{(1 - v^2/c^2)}}$

Likewise, if $t' = \frac{t - (v/c^2)\,x}{\sqrt{(1 - v^2/c^2)}}$ then: $dt'/dt = \frac{1 - (v/c^2)dx/dt}{\sqrt{(1 - v^2/c^2)}}$

This gives:

$$dx'/dt' = \frac{(dx/dt - v)}{\sqrt{(1 - v^2/c^2)}} \times \frac{\sqrt{(1 - v^2/c^2)}}{1 - (v/c^2)dx/dt} = \frac{(dx/dt - v)}{1 - (v/c^2)dx/dt}$$

Now x and t refer to the static frame, where the rate of motion, dx/dt, is zero.

Substituting this into the above expression we get that: v' (*i.e.* dx'/dt') = $-v$

So it appears that S's apparent speed, as measured by G, is indeed equal and opposite to G's own actual speed.

We can check this by considering G a short time after it initially passes S. [N.B. T and t are being used here to represent different values from those they're used for in our previous scenario.] We'll imagine that at some time T as shown on G's clock a light-signal is sent back from G to S. On reaching S it's immediately reflected back up the line to reach G again at a time shown as $T + t'$ on G's clock.

We'll use the standard symbol γ to represent the ratio of true time relative to the slowed pace of time as shown on G's clock. So the true time t for the light-signal to travel from G back to S and then return to G is given by: $t = \gamma t'$; also the true time after G passes S that the light-signal is sent is given by γT.

We then have matching distances, given by times x speeds, of light and train respectively (in time t light travels from G to S then back to G, now moved on):

$$t \times c = v \times \gamma T + v(\gamma T + t) \quad \text{[Distance of light travel from G to S and back.]}$$

Rearranging this equation to give t in terms of the other values, we get:

$$t = \frac{2\gamma v T}{c - v} \quad , \qquad \text{or} \qquad t' = \frac{2vT}{c - v} \qquad (1)$$

If s' represents the distance of S from G, as perceived by G, at the time the signal reaches S [remember that in G's perception S is moving away at speed v' from stationary G, in the opposite direction from G's own actual motion] then:

$$s' = t'c/2 \quad \text{[Half the perceived return distance light travels in time } t'\text{]}$$

And also:

$$s' = v'(T + t'/2)$$

[S is perceived to be moving away at speed v' for initial time T + half of the time t' by the time the signal reaches S]

This gives us: $\quad t'c/2 = v'(T + t'/2)$

which rearranges to: $\quad t' = \dfrac{2v'T}{c - v'}$

Equating that to (1), we get: $\quad \dfrac{2v'T}{c - v'} = \dfrac{2vT}{c - v}$

which cross-multiplies and cancels to give:

$$v' = v$$

In other words G perceives S to be moving at the same speed as G is itself actually moving (in the opposite direction, of course). This is as given by the differentiation process on the previous page.

This result confirms that the inverse of the Lorentz Transformation from a static reference frame to a moving frame – namely from the moving frame back to the static frame – exactly mirrors that original transformation. The original transformation and inverse transformation are indeed symmetric, as in Relativity – but for very different reasons.

It's extremely important to see what's happening here. Relativity tells us that transforming from any one inertial frame of reference to any other follows an identical process. This view follows from the presumed equivalence of all such reference frames and appears to support that perspective.

However the spun-light understanding of matter points to one unique absolutely static reference frame characterised by static particles in that frame whose formative energy flows are wholly cyclic, with no linear component in those flows. It goes on to identify all other reference frames as being in various states of motion (*i.e.* non-static), in which apparently-static particles incorporate a linear component to their formative energy flows.

Remarkably, this *Preferred Frame* reality gives a transformation scenario, for shifting from the perspective of one frame to another, that's ***identical*** to the scenario in the symmetric-frame model of the universe proposed by Relativity. A space-time reality based on one uniquely static reference frame with all other reference frames moving around it gives every appearance, in terms of times and distances, of instead being a reality in which all inertial states of motion are equivalent – frame symmetry, as enshrined in Relativity Theory.

The take-home message from all of this, once again, is that it's not necessary to introduce a special metaphysical property of light to explain the apparent symmetry of different states of motion; this is simply a subjective consequence of the light-formed structure of material particles.

As we'll see in the next chapter, the spun-light structure of matter is very persuasive in other ways also in giving the impression of frame symmetry. The only clues to the contrary are at the astronomical level, in the form of the *Cosmic Microwave Background*, and the subatomic level in the form of the waveforms of the energy flows forming elementary particles; more on this in Appendix E and Chapter 9, respectively.

It's vitally important that we get beyond this limiting perception. The illusion of frame symmetry is highly restrictive; arguably the mystery of gravitation has been insoluble up to now because of that restriction, there may be other important aspects of reality that simply aren't apparent from this restricted viewpoint. Just consider, as an analogy, how our world and our universe have opened up for us since we got beyond the mindset that the visible-light spectrum was all there was to what we now know to be electromagnetic waves!

To use another analogy, it was only when Edwin Hubble discovered the true nature of so many of those fuzzy *nebulae* in our night skies that we became aware that our galaxy was just one among countless billions of others. What other secrets is nature just waiting to unfold for us?