Special Relativity Effects Are Optical Illusions (Abridged Version)

by David Johnson

According to Albert Einstein's theory of relativity no object can be accelerated up to or faster than the speed of light. Even approaching that speed causes very strange things to happen, according to the theory: the object becomes more massive, approaching an infinite mass the closer that it gets to the speed of light, it shrinks in the direction of motion, and time slows down.

Length Contraction

One would not ordinarily think that an object's length would be affected by how fast it is moving, but that is exactly what is purported to be the case in the theory of relativity. There is some experimental evidence that is used to support this, and other scientists in addition to Einstein argued for it, most notably Hendrik A. Lorentz. (Einstein even refers to the calculation of it as the 'Lorentz Transformation'.) The idea seems to have originated with an Irish physicist named George Francis FitzGerald in 1893. FitzGerald said that all matter contracted in the direction of its motion and that the amount of contraction increased with the rate of motion. He believed that all measuring devices, even human sense organs, would also be 'foreshortened' in the same way. (This was originally meant to explain why they could not detect the aether.) For some time the phenomenon was even referred to as the 'FitzGerald contraction'. He worked out an equation for it, and knew that it would take very high speeds for the contraction to be significant. At half the speed of light it would be a 15% contraction, at 7/8ths the speed of light it would be 50%. At exactly the speed of light its length would be zero. Since there can be no length shorter than zero, FitzGerald concluded that the speed of light must be the greatest possible velocity.

Lorentz built upon FitzGerald's idea. He reasoned that if the charge of a charged particle was compressed into a smaller volume the mass of the particle would increase. Lorentz presented an equation for this mass increase that was similar to FitzGerald's equation for shortening. At half the speed of light the mass would be increased by 15%, at 7/8ths the speed of light it would double, and at the speed of light its mass would be infinite. Lorentz thought that it would be impossible for an object to exceed the speed of light as well because nothing could have a greater than infinite mass. These equations are so closely related that they have sometimes been lumped together as the 'Lorentz-FitzGerald equations'.[1]

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[1] I got most of this information from *The New Intelligent Man's Guide to Science* by Isaac Asimov. Other sources that I used for other sections include *Relativity: The Special and General Theory* and 'On the Electrodynamics of Moving Bodies', both written by Einstein, as well as *Einstein For Everyone* by John D. Norton, and *The Mechanical Universe* video series from Caltech. In addition to these there were several other online sources and science books written for the general reader, but that was all information that is widely available through many sources, so I don't think I need to cite them. All of the sources that I used were defending and explaining the theory of relativity so one should be aware that I have drawn different conclusions than the authors of these sources did. You can consult those sources directly to find out how they interpret the data and what their arguments are.

All of this is very similar to the views espoused by Einstein in the special theory of relativity. Many sources omit the history of how these ideas developed over time, which gives the impression that Einstein came up with it all entirely on his own. I do not necessarily fault him for that, because he does give Lorentz, Hermann Minkowski, and others credit for their contributions to the theory in his own writing. (Although he only briefly mentioned FitzGerald; he could have said more about him. He definitely should have cited Poincaré as will be discussed below.) It is often the case that new theories build upon and refine the work of those that came before. But it is misleading to present the theory as though Einstein came up with it all himself in one great stroke of genius.

I am not actually surprised that there is some experimental data that supports length contraction: if indeed the speed of light is constant then one would expect that when an object is traveling at near that speed it would affect how the image of that object is perceived by the viewer. Where these gentlemen and those who followed them have gone wrong, however, is in assuming that the object itself shrinks when in reality it is just the image that becomes distorted.

We have to remember that we do not actually see objects themselves, what we see are light waves bouncing off of those objects. A flat mirror image can look almost exactly like the real three-dimensional object because of reflected light. My explanation for the phenomena is that when an object is traveling at high speed relative to light the light waves become compressed in the direction of motion, which is perceived by the viewer as the object shrinking.

You may have noticed before that when an emergency vehicle passes by you at high speed there seems to be a sudden change in the siren's pitch. This is an example of what is known as the Doppler effect. It happens because the motion of the emergency vehicle makes it so that the sound waves are closer together when it is coming towards you than it would be if both you and the emergency vehicle were stationary. This increases the frequency of the sound waves striking your ear, which is why the pitch sounds higher. When the siren is moving away from you the sound waves are further apart than they would be if you were both stationary. This decreases the frequency and causes you to hear a lower pitch. The Doppler effect happens whether it is the source of the sound that is moving, and/or the observer is moving. If you were in a car and drove past a stationary siren the pitch would sound higher as you approached it and lower after you passed it and drove away. (There is a slight difference in how it is perceived depending upon whether the observer is the one moving, or the siren is moving, but it would not be very noticeable in most cases.)

I believe something similar is happening with length contraction: it is really just an optical illusion created by Doppler shift. I consider it an optical illusion because it is just a change in how the object is perceived, not a change to the object itself. It is simply not true that a measuring rod actually shrinks, which explains why its appearance does not change to an observer who is traveling with the rod. If the measuring rod itself really became shorter as a consequence of its motion that should be apparent to observers within the same reference frame, but the theory of relativity says that for those observers the length would look and even be measured the same as if the reference frame was not moving at all. It is only from the perspective of other reference frames (where the observer is not moving with the rod) that the rod would appear to be shorter. This is an important clue that the 'shrinking' is not a genuine physical effect on the rod itself.

According to the theory, the reason that length contraction is undetectable to observers within the same frame of reference is because the observers themselves would also shrink by an equivalent amount, along with all of their measuring instruments (similar to what FitzGerald said). A man that was 2 meters tall could lie down and he would shrink to two centimeters in the direction of motion if the spaceship he was traveling in went fast enough; not only would he survive, he would not even be aware of it, and once the ship slowed down to a speed close to where it was originally he would go back to being 2 meters long and suffer no ill effects from the contraction. If he was standing up rather than lying down the thickness of his body would be compressed to practically nothing; but there is no fear that his internal organs would be damaged, or his rib cage crushed, because they would all shrink by the exact same amount. Then it would all go back to normal once the ship slowed down and he would not even be aware that the shrinking had happened. Actually, from his perspective it did not happen, since he and all the observers within that reference frame would measure everything to be the same length throughout the whole process.

If length contraction really happens to the object itself, how could a biological organism survive it? We are talking about being compressed to 1/100th his prior length. Even if we say that the shrinking does not occur within his own frame of reference (it is unclear whether relativity theory would say that or not), it seems to me that he ought to be dead, at least from the perspective of observers in the frames of reference where such dramatic shrinking is observed. Is he alive in some frames of reference and dead in others? Does 'relativity' extend that far? But if that were the case he would also have to come back to life in those other frames once his frame slowed down, with no indication that he had ever been crushed down to two centimeters. If you think that sounds absurd I would have to agree, but wouldn't it be just as absurd to say that someone could be compressed from a length of two meters down to two centimeters and yet have no negative health effects from it?

Another clue that this is not a genuine physical effect on the objects is that it does not matter what kind of material the objects are made of, they all supposedly shrink by the exact same amount. A refrigerator would shrink proportionally by the same amount as a table or a bed. A measuring stick made of wood would not break when contracted, even if it went from a meter long to a centimeter, and it would shrink by the exact same amount as a measuring rod made of metal. One would think that metal objects would be permanently deformed by the contraction, as they would be if they were crushed in a hydraulic press. The material has to go somewhere, it does not just disappear (does it?), so if its length was contracted its thickness should increase, and one would think that this would be a permanent change, even once the frame was slowed down. So why wouldn't a wooden measuring stick break, and why wouldn't a metal measuring rod get thicker as it got shorter, and why would they both magically go back to the way they were before once the reference frame was slowed down to its prior speed? What physical mechanism is causing this?

Length contraction seems very implausible when it is supposed to be something that happens to the objects themselves, as relativity theory asserts, but if it is just the light waves that are being compressed then it makes a lot more sense. That would explain why everything, no matter what material it is composed of, even organic things, all seem to shrink by the exact same amount, and then go back to normal once the reference frame is no longer moving at such a high speed (because then the light waves would no longer be compressed).

In relativity theory it is thought to be impossible to take a disk made out of stiff material and set it into rapid motion at speeds near the speed of light because it would contract in the circumferential direction (the direction of motion) but not in the radial direction. This would cause the disk to break apart. Einstein acknowledged this implication of his view, and suggested that a way to get the disk into rotation would be to melt it first, then set the molten material into rotation and allow it to harden while spinning. That may or may not actually work: I am not really sure how it would have a chance to harden before the centrifugal forces caused the material at the circumference to fly outward so much that it ruined the shape. Perhaps it would depend on the material, but I think it is unlikely that it would work with molten metal unless you used a form (maybe not even then), and of course then the same problem would arise with how to accelerate the form up to speed without it breaking apart. At any rate, it does not really matter whether the proposed solution would actually work or not, the reason that I bring it up is that I think it is odd that Einstein and other scientists recognized that the rotating disk would break apart but there seems to be no recognition at all that a measuring rod composed of stiff material, such as wood, would break simply from being compressed in the direction of motion, and that it would obviously kill biological organisms. (As for my own prediction about what would happen with the rotating disk, I do not think that it would shrink or even appear to shrink in the circumferential direction because there would be no Doppler shift from having it spin; the only concern with rotating it that fast would be overcoming the immense centrifugal force; that is the real reason that the disk would probably break apart.)

There are many examples of how our visual perceptions can be distorted. One of these is refraction. If you have a straw or a spoon that is partially in water and laying at an oblique angle (slanted) it often looks like it is bent or even cut in half where it enters the water. I watched someone cleaning a pool one time with a net that was attached to a very long pole. The refraction was extreme. It looked like the pole was cut in half right where it entered the water and the part that was in the water looked like it was offset by about four inches from the part that was above the water, and it looked bent. But of course I knew that this was just an optical illusion because I knew about refraction, so I never thought that the pole was actually cut in half. Just as I suspected, once he pulled it completely out of the water I could see that the pole was not cut in half, and it was extremely straight. One could make a relativistic argument about this and say that my observation when the pole was in the water was as good as any other observation, because that truly is what I perceived, and I know that at least one other person perceived it that way as well (namely the person who was cleaning the pool, as I commented on it and then we discussed it) so it was not an inaccurate perception. But I think that it would be wrong to insist that the pole really was cut in half for me at that time even if that is what I observed. We know about refraction and what causes it, and we know from experience that when we take the object out of the water it is not really bent or cut. But it sure does look that way, because what we perceive is light, and since light travels at a different speed in water than it does in air, it distorts the image without affecting the actual object.

It is well-known that the Doppler effect occurs with light waves: the red shift and blue shift that we see from distant stars is a result of the frequency of the waves being affected by the light source's motion (and/or our motion). When the object is not a light source we see it by light that is reflected off of it, so there would probably be no red shift or blue shift, it would simply distort the image. (Because it is not the light source or the viewer that is moving at near the speed of light, it is the object.)

Perhaps this is somewhat like radar and sonar (and/or echolocation, which is used by several members of the animal kingdom). A radar set can measure Doppler shift quite accurately to determine the speed of an airplane or a car. Police often use a radar gun to determine whether a car is speeding. For stationary radar a pulse of electromagnetic waves is emitted by the gun in the direction of a car that is moving toward the gun. Some of the waves will bounce off the car and return to the receiver of the radar gun. Because the car is moving toward the gun the waves are compressed and have a higher frequency than the frequency of the original pulse that was sent out. By measuring the difference the radar gun can determine how fast the car is moving. It also works when an object is moving away from the source. In that case the returning waves will have a lower frequency than the original.

There are obviously some differences between this and how we see: for one thing our eyes do not emit a beam of light. But there is an important similarity: since we know the formula for how much an image is distorted at particular speeds (the 'Lorentz Transformation' which is a refinement of FitzGerald's equations), the amount of length contraction could be used to determine the object's speed, similar to radar. The 'Lorentz Transformation' is a measurement of Doppler shift.

Time Dilation

Einstein expanded on the original idea from FitzGerald and Lorentz to also include time. He believed that at speeds approaching c time itself would slow down for that reference frame, so the frame's clocks would run slower in addition to measuring rods being contracted in the direction of motion. (Einstein used the letter c to stand for the speed of light, which was common among scientists at the time he was writing. Lorentz and Max Planck, among others, also used it to stand for the speed of light.)[2] This relativistic slowing of time is sometimes referred to as 'time dilation'. I believe that this effect is also because of Doppler shift.

Imagine that we have two spaceships that are stationary relative to each other and are exactly one light year apart. At a previously agreed upon time and date one of the ships begins to flash a light signal every 10 seconds. The light stays on for half a second then goes off for the remaining 9 and a half seconds until the next flash. This is like a rudimentary clock. Observers in the other ship know that, as previously agreed upon, the light is set to flash every 10 seconds, and while both ships are stationary this is exactly what they observe; it takes a year for those in the observation ship to begin receiving the signals, but once they do they measure a 10 second interval from the beginning of one flash to the beginning of another.

After sending these signals for 24 hours, in accordance with a predetermined plan, the ship sending out the light flashes begins to accelerate towards the observation ship while the latter remains stationary. Would you predict that the observers in the stationary ship will see the light flashes occur with exactly the same frequency, less frequency, or greater frequency as the other ship moves towards them in a direct line?

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[2] It is unknown what the letter originally stood for, if anything; they may have just picked a letter randomly. But two other possibilities are that it originally stood for 'constant', or perhaps the Latin word celeritas which means 'swift' or 'speed'.

The theory of relativity says that the observers will see the light flashes come with less frequency because time slows down for the ship sending out the signals as its speed gets closer to the speed of light. Suppose that they accelerate to half the speed of light and then maintain that as a constant velocity; even though according to their own reckoning of time, which includes all of their ship's clocks, they are still sending out the signals every 10 seconds, because of time dilation it will be judged to be more than 10 seconds by the stationary observers.

But let's think about this carefully; how could that really be true? If the ship is traveling at half the speed of light then it covers 1,498,962,290 meters in 10 seconds (c = 299,792,458 m/s, multiplied by 5, or .5 c = 149,896,229 m/s, multiplied by 10). This means that each time a new light signal is emitted the ship is 1,498,962,290 meters closer to the observers when the new signal begins than it was when the last signal began. Since the ship has already covered this distance during the interval between signals the light no longer needs to traverse it in order to reach the observers. Because the speed of light is a constant, we know exactly how much time it would take for light to traverse that distance: 5 seconds. So, the new signal should reach the observers 5 seconds earlier than it would have if both ships were stationary. This is simply because the ship is 1,498,962,290 meters closer to the observers than it would otherwise be. Thus, the frequency of the light signals would be observed to increase from the reference frame of the stationary ship. It would appear to those observers that there was only a 5 second interval between the beginning of one light signal to the beginning of another. This is not surprising: since the ship is traveling at half the speed of light one would expect that the interval between signals would be cut in half. By the same reasoning, if the ship had a velocity of .8c then the interval between the signals would be cut by 80%, meaning that it would be down to 2 seconds from the beginning of one signal to the beginning of another. This is equivalent to time appearing to speed up as the ship approaches the speed of light, not slow down.

Time would appear to slow down if the ship was moving in the opposite direction, meaning directly away from the observers. If it were moving in that direction at half the speed of light then it would be 1,498,962,290 meters further away from the observers at the beginning of each new signal. Since it takes light 5 seconds to travel that extra distance, it will take 5 seconds longer for the signal to reach the observers than if the ship was stationary. Thus, to the observers in the stationary ship it would look like the light signals were coming in 15 second intervals.

This probably all seems fairly obvious, and it is, but it is important to realize that this is not what the theory of relativity predicts. If the ship is traveling at half the speed of light then observers outside of that frame of reference (who are not going as fast) are supposed to see time slow down for it, regardless of its direction. Time dilation is solely a function of speed, so it should occur whether the ship is coming directly toward the observers, going directly away from them, or moving sideways relative to them.

The theory of relativity asserts that all physical processes slow down as a reference frame approaches the speed of light, even a person's metabolism. If the ship was moving at .95c the prediction is that a crew member's metabolism would slow to only 4.5% of its normal rate. This would dramatically slow the aging process.

But it is not really time itself that speeds up or slows down, it just appears that way to the observers in the stationary ship because of Doppler shift. If those observers were watching what was happening on board the other ship, either through a powerful telescope or by watching a live video feed, it would look like things were happening faster than normal if the signal ship was coming toward them. The people would seem to be talking and moving around faster than they ordinarily would. If a man was growing a beard it would seem to be growing faster than normal, along with everyone's hair. But we should not assume that time itself is speeding up for them, it is just that the signal ship is getting closer to the observers so the lag time between when something actually happened and when the observers see it is decreasing. Once an observer is close to the event that is being observed the lag time becomes nearly nonexistent; in our everyday experience we can usually observe something almost instantaneously to when it actually happened because the speed of light is so fast. But at great distances that would not be the case. One can often notice a slight delay when live interviews or video conferences are conducted from halfway around the world. This effect would have some similarities to that as far as how it would be experienced but it would be much more pronounced.

Once the two ships were close to each other and both were at rest relative to the other, or everyone was on the same ship, the two crews would find that exactly the same amount of time had passed for them both. No one's metabolism would have actually slowed down or sped up. Everyone would have aged by the same amount, and it would be no different than if they had all remained stationary in the same reference frame the entire time. While it would have appeared to each crew that the clocks of the other were running faster or slower than their own (depending on the direction of travel) during the experiment, they would find once they were back together that their clocks were fully synchronized. This explains why neither ship's computer or any of the clocks that they had on board ever detected any slowing of time: it is because time did not actually slow down, or speed up, it just looked that way to observers a great distance away because of an optical illusion.

If you say that time dilation is an actual physical reality then not only are you saying that time slows down for the ship giving the signals, but also that time speeds up for other reference frames. That is actually a more accurate way of expressing the claim because observers on the signal ship always judge the light flashes to be occurring at the exact same rate of 10 seconds. The signals do not slow down, according to them. So, rather than saying that time slows down for the signal ship, we should say that time speeds up for the other reference frames, including the observers in the stationary ship. Because their clocks begin to run faster than the clocks on the signal ship as the signal ship increases its speed the stationary observers will judge the same interval between the light flashes to be more than 10 seconds while it remains 10 seconds to the observers in the signal ship. But think about it, isn't that a bizarre claim? The stationary ship has not moved at all during this experiment, yet its time (along with the time of other reference frames) is altered by the motion of some other reference frame a great distance away? Why?

Moreover, relativity theory is quite unclear about what observers on the signal ship will see as they observe events taking place on the stationary ship. On one hand the theory asserts that inertial motion is relative, so once the ship is moving inertially those observers could just as easily regard themselves as being at rest and the other ship to be moving at .5 c. Because of that, the prediction would be that they will see time slow down for what I have been calling the stationary ship. But the theory also says that when the two ships are back together it will only be the crew members from the one giving the signals that will have experienced time dilation, so they will have aged less and their clocks and calendars will have run slower than the stationary ship. So which is it? Either observers on the signal ship see time for the other ship slow down or they see it speed up, it cannot be both. If they really aged less and their clocks ran slower, and this was apparent once the two crews were back together, then it ought to be that way throughout the experiment. But if that is the case then you would have a way of detecting absolute motion; the frames of reference in which time is running the fastest are closest to an absolute state of rest and those that are running the slowest are, or have been moving at speeds closest to the speed of light. (Stronger gravitational fields would need to be accounted for, according the theory, but that could be done.) This is something that Einstein would explicitly reject because of the principle of relativity, but the theory is not consistent in what observers on the moving ship will see when they observe events on the stationary ship.

It should here be noted that there is no inconsistency at all if we regard time dilation as merely an optical illusion. It is perfectly acceptable to say that when the signal ship is moving away from the stationary ship both will see time slowing down for the other because they are moving further apart, and when the signal ship is coming towards the stationary ship both would see time speeding up for the other because the distance between them is becoming shorter. It is consistent to say this because we are not talking about actual time, it is just their perception of events on the distant ship. Because events that happen on their own ship are very close to them they see those events as taking place in ‘real time’, and the events that are taking place on the other ship as speeding up or slowing down depending upon whether they are getting closer to them or further away.

I doubt that anyone would think that time itself speeds up or slows down for listeners who perceive a change in pitch from the siren when an emergency vehicle goes by them. You could interpret the Doppler effect that way, if you wanted to: One could argue that the reason the pitch changes is because time is moving faster (or slower) for those traveling in the emergency vehicle as it approaches the speed of sound than it is for a listener in another reference frame. But is that really the most reasonable explanation of the phenomenon?

Now imagine that the ship transmitting the light signals moved horizontally relative to the observers in the stationary ship. This would create an imaginary right triangle: one side is the distance between the two ships initially (one light year), the side opposite the observers is created by the path of the ship, and the hypotenuse is the straight line distance between the two ships. As the ship moves the side opposite the observers and the hypotenuse grow longer. Since the hypotenuse is getting longer we know that the ship is moving away from the observers. This means that the interval between the light signals will get longer. It would start off being only slightly more than 10 seconds but the difference would grow larger as it went along. Thus, the observers would perceive time to be gradually slowing down for those in the other ship.

Suppose that after proceeding this way for awhile, the ship came to a complete stop and stayed that way for a full 24 hours. The light signals would go back to having an interval of exactly 10 seconds. Now imagine that the ship turns around and retraces its former path. Once it starts moving the interval between the light signals would be less than 10 seconds because the hypotenuse of the triangle is shrinking, which means that the ship is getting closer to the observers. It would take it awhile to accelerate back up to full speed (.5c), but once it was up to speed the interval would shrink the most when the triangle is the largest; this means that as the ship gets closer to its initial starting point the interval between signals would be getting longer, getting closer and closer to exactly 10 seconds. When it reached the initial starting point it would be very close to exactly 10 seconds because this is nearly equivalent to being at rest in terms of moving towards or away from the observers. But let's say that it goes past the initial starting point and continues on; then it would begin to create an imaginary right triangle on the other side and would begin moving away from the observers as the hypotenuse of the triangle (on the other side of the imaginary straight line between the two ships at the starting points) gets longer, and the interval between signals would increase. Once again we see that when the ship giving the signals is moving toward the observers the interval between signals decreases ('time' appears to speed up), and when it moves away from the observers the interval increases ('time' appears to slow down).

For the most part, it would look the same to the observers whether the ship giving the signals was the one moving or they themselves were moving and the signal ship was stationary, or if both were moving at .25c so that it is equivalent to one moving at .5c. However, there are some differences, which, while subtle at speeds below the speed of light, become more apparent at or above the speed of light. This will be discussed further in the next section.

The Speed of Light

The theory of relativity has a really weird preoccupation with the speed of light. There is nothing particularly special about it, it is just the speed at which electromagnetic waves happen to propagate. Why not choose the speed of sound waves through air, or seismic waves, or the speed of any other kind of wave as the top speed instead? Do we really think that the speed at which galaxies move away from each other is somehow constrained by having to go at some speed less than the speed of light?

Einstein and the scientists of his day thought that nothing could exceed the speed of light. This has since been amended because scientists have now found evidence through the experiments conducted at the various particle colliders that there could be particles, called tachyons, that do actually move faster than light. Now the claim is that it is impossible for tachyons to be slowed down to the speed of light and impossible for other particles - the ones that compose the objects we are familiar with - to be accelerated up to or beyond that speed.

Similar to Lorentz's view, relativity theory asserts that objects become more massive as they approach c, which is meant to explain why they cannot be accelerated up to or beyond that speed; according to the theory, as an object approaches c its mass approaches infinity. No amount of energy could accelerate an infinite mass. This secondary mass is rather mystical. It is not the regular mass of the object, which relativity theory refers to as the 'rest mass'. The so-called 'rest mass' does not change depending on the object's speed.

This whole concept of 'inertial mass' seems ad hoc. Its only purpose is to explain why objects cannot be accelerated up to the speed of light. If that is not true then there is no reason to believe that there is such a thing. If length contraction is merely an optical illusion there is no reason to accept Lorentz's explanation that the particles become more massive as they are contracted into a smaller space, as they are not actually contracted.[3]

I do not believe that objects become more massive as they are accelerated. Experimental results that supposedly indicate this are probably just picking up the resistance that the particle is experiencing as it is accelerated. When a fighter jet approaches the sound barrier there is increased drag, reduced controllability, etc. There may indeed be some resistance at the speed of light as well, especially for a tiny particle. For a charged particle there could even be electromagnetic resistance. It would probably be easier to get a large object with a lot more mass (and therefore more momentum) to actually break through that resistance, but it would be more difficult to accelerate it up to that speed to begin with. The biggest challenge is actually just that the speed of light is really really fast. But I do not think that it would be impossible. In fact, if the human species survives another 5 to 10 thousand years without bringing about its own extinction I would not be too surprised if someone eventually figured out how to do it. Perhaps it will be even sooner than that.

So, the question naturally arises, what would you see if a spaceship was going faster than light? I mentioned previously that there are some differences in how it would be perceived when it is the observer that is moving versus when it is the object which is being observed that is moving. These differences would become much more noticeable if we assume that the speed is exactly c, or greater than c. It takes a little bit less than eight and a half minutes for the light emanating from the sun to reach earth. If the earth was moving away from the sun at the exact same speed, when we looked back in the direction of the sun it would seem like nothing had changed. We would be traveling along with the current wave and could not perceive any that come after it, so no new information would be transmitted to our eyes. It is not the case that time actually stops, of course; the change happens at the same rate regardless of when or if it is observed, but when we looked in that direction it would look like everything was frozen in place. Thus, if the observer is moving at exactly the speed of light it would appear as though time had completely stopped in the direction that is opposite her motion (i.e. behind her); in the direction of motion it would look like time was moving twice as fast as it normally would.

Now suppose that we have a viewer that is stationary and a spaceship that is moving away from him at near the speed of light. The viewer would see time appear to slow down for that ship and its occupants. It would look like everything on board was happening in slow motion, and the closer that the ship got to the speed of light the slower everything would appear to move. One might think that if the ship was traveling at exactly the speed of light everything would be frozen in place and it would look like time was standing still, just like when it was the observer that was moving; after all, the light would be moving at exactly the same speed as the spaceship so it seems like they would just cancel each other out and no new information about what is happening on the ship would reach the observer; perhaps if the ship was going faster than c time would even appear to move

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[3] Some sources on relativity use nuclear power as evidence for mass-energy equivalence and for 'inertial mass'. Nuclear power plants and nuclear weapons are obviously a reality, but I think that one can acknowledge that breaking nuclear bonds in a reaction releases a tremendous amount of energy without necessarily saying that this proves that an object's mass increases to infinity when it is accelerated up to the speed of light.

backwards. But this is not the case. Once the light is emitted it has its own velocity and propagates from that location rather than the current location of the source, so it would eventually reach the observer as long as the observer's velocity is less than c. If the observer was moving faster than light it would be possible to outrun the waves so that they never overtake the observer, but even if the object that emitted the light was going faster than c the light itself would still reach a stationary observer at the speed of light.

The easiest way to visualize this is to imagine a small plane flying over a lake with someone dropping rocks out the window. The waves created by the rocks will spread out at the same rate regardless of how fast the plane is moving. The plane moves faster than the water waves that are created, so the waves never catch up to it. If you were walking or running along the shore and you moved faster than the rate at which the waves spread they would never catch up to you either. But if you were standing out in a shallow part of the lake the waves would eventually reach you, since you are stationary. Thus we may conclude that for any observer that is stationary or moving slower than the speed of light, the light waves will eventually overtake them.

If an airplane is traveling faster than the speed of sound you do not hear it until the sound waves reach you, even if visually you can tell that the plane is far ahead of the sound waves. If a spaceship was traveling faster than the speed of light you would not be able to see it. Instead, you would probably see something equivalent to a visual sonic boom. From a great distance this would look like the front end of a cone that was bluish purple at the tip. This is similar to a Mach cone that forms with sound waves. The sound piles up into a single shock wave that spreads out in a conical shape behind the plane. If an observer is in the 'boom carpet', or in other words within range of the cone as the plane passes by, they hear the 'boom'. (Technically the 'boom carpet' refers to where the Mach cone meets the ground, but I think it would be the same effect if the observer was not on the ground.) If an observer was within the cone that I am describing they would likely experience it as a sudden intense flash of purplish blue light. Neither this observer nor the person outside the cone observing from a distance would be able to see the ship itself until it slowed down to less than the speed of light and the waves had a chance to catch up to it.

If the object did not emit light (which means that we can only see it from the light waves bouncing off of it) there would still be a cone but it would be less noticeable. We can infer that this is the case from the fact that supersonic bullets still create shock waves even if they do not emit any sound themselves because they slice through the air faster than sound; but it is less than a supersonic jet (even accounting for the difference in size) because the roar of the jet's engines piles up so that the boom is louder and more intense. Based upon this, one would expect that a meter long measuring rod that does not emit any light itself would not create a flash that is as intense as the one created by a spaceship that is itself a light source in addition to reflecting light. All of that light would build up into one wavefront, which could be pretty intense for viewers within the cone.

One of the reasons that Einstein (following FitzGerald and Lorentz) believed that the speed of light could not be exceeded was that it seemed as though the equations showed that if an object reached the speed of light its length would be contracted to zero. But its true length would not be zero, the zero simply represents the fact that you would no longer be able to see it. (You would instead see the Mach cone.) The same is true for negative values. The theory says that if an object exceeded the speed of light it would have negative or imaginary values for its length, which seems absurd, and that was one of the arguments for why no object could be accelerated past the speed of light. But the measuring rod's length would not really turn negative. Just as length contraction could be used to indicate its speed as it approaches the speed of light this could be used to show how much faster it is going than light. Mach numbers could be described negatively. Mach 2 could be thought of as -1, Mach 4 could be thought of as -3, Mach 3.2 as -2.2, and so forth. In this case the negative values represent how much faster the object is going than the speed of sound which is set at 0.

Many scientists and other intellectuals think that time travel is at least theoretically possible because they believe that time dilation is an actual physical reality, so if you could somehow figure out how to go faster than the speed of light they believe that the time dilation would become negative and this would be a way of traveling back in time. I obviously do not believe that myself because I think that time dilation is just an optical illusion.

If you could travel at speeds faster than the speed of light you could see into the past, in a sense, but you could not travel back in time because 'past' and 'future' are not spatial locations that one can travel to. In a way, we get to look back in time when we look at distant stars because what we see now is actually how they were thousands of years ago rather than how they are right now. We cannot know what they look like right now until the light that contains that information reaches us. If you could move ten times faster than the speed of light you could rapidly change your position, which means that if you moved in the direction of those stars you would quickly be able to, in a sense, see into the future relative to the earth. One is not really seeing into the future, of course, all that you would be doing is decreasing the lag time from when something actually happened to when it is observed, and so it would really only apply for distant objects such as stars in other galaxies; in that sense only would going faster than light allow us to see into the future or into the past, and there is a limit even to this. You could only go back to the point of origin where the light was emitted. Once you are close to that point you would be able to observe the change almost simultaneously to when it happens so there would be no more 'seeing into the future'. 'Seeing into the past' would still be possible by moving away from the light source, but of course you would also be increasing the distance, so it wouldn't be equivalent to seeing how things looked in the past from the prior vantage point.

Imagine that a spaceship traveled a distance of 10 light years in only 5 years. In that case, observers would be able to see 5 years into the past in the direction opposite their motion. It takes light from the sun 10 years to reach that point in space, but it only took them 5 years to reach the same point. So they would be able to observe how earth looked 5 years earlier from that vantage point (but 5 years later than the date that they left). Now suppose that they went back to earth, once again traveling a distance of 10 light years in 5 years time. On the return trip it would seem like events on earth were happening much faster than normal, and, of course, to observers on earth it would seem like events on the spaceship were happening much faster than normal. But once they were back on earth everything would be back to normal and exactly 10 years would have passed for those on earth and those in the spaceship. They would find that the ship's clocks were fully synchronized with earth's clocks.

We have discussed what would happen if an object was actually moving faster than the speed of light, but what if it was the combined speed of that object and another that was greater than the speed of light? Suppose that we have three spaceships: one is stationary and is right in between two other ships that are both moving away from it at .7c. We can imagine a coordinate plane and say that the stationary ship is located at coordinates (0,0,0). We will say that the other two ships are moving in opposite directions in terms of their x coordinate, and they also move up the y plane at a very very slight incline just so that their view of each other is not obstructed by the ship in the middle.

An observer on the stationary ship will say that both of the other ships are going .7c, which would imply that they must be moving away from each other at very close to 1.4c, an apparent violation of the theory of relativity. But the theory has an answer for this. If those on ship A were to measure the velocity of ship B the equations that Einstein used say that observers on ship A would judge themselves to be at rest, the stationary ship to be moving away from them at .7c, and ship B to be going at a speed slower than the speed of light. (He uses a 'reduction factor' to ensure that when the velocities of objects are added together they still remain below the speed of light for all observers.) The same would be true if observers on ship B were to judge A's velocity. We have to remember that in the theory of relativity there is no absolute fact about speed and/or the timing of events; whether something is moving or at rest, or how fast it is moving is all relative; something can only be said to be moving or at rest relative to some other body. From the stationary observer's viewpoint both ships are measured to be moving at .7c, but observers on those ships will measure it differently. Thus, according to the theory, none of the observers will measure the others to be going faster than the speed of light.

I will address Einstein's claims about relative motion in the next section, but I believe that what would really happen in this case is that their observations of each other would simply be delayed. There would not be the visual equivalent of a Mach cone because neither ship is actually going faster than light. Suppose that all three ships emitted a light signal simultaneously: what would observers on each ship see? Observers on the stationary ship would see both signals from the other ships simultaneously. Observers on ship A would see B's signal long after the signal from the stationary ship, but this is just because of the much greater distance that light has to travel from B to A than from the stationary ship to A. Once the light is emitted it moves at the speed of light in all directions, regardless of B's velocity, so it would eventually overtake A, since A is only going .7c. We see from this thought experiment that when the combined speed of two bodies sums to a value greater than the speed of light it creates a different visual effect than when one of them is actually going faster than the speed of light.

The Principle of Relativity

The speed of light is important in the theory of relativity in another way. In what Einstein calls 'the light postulate' he claims that all uniformly moving observers (which would include those at rest) must measure the same speed for light. In the example that he gave, he said that an observer on a moving train will measure the same speed for light (in all directions) as a stationary observer standing on an embankment next to the train. Well, it is true that light waves always propagate at the speed of 299,792,458 m/s, or 186,282 miles per second in outer space. Just like other waves, light waves expand from the source at the same rate regardless of how fast the light source or the observer is moving. But there is something very wrong with the light postulate. It is related to Einstein's other postulate, the principle of relativity, in which he argues that the laws of physics must be the same in all reference frames.[4] That may initially sound reasonable enough, but he interprets that to mean that no matter how fast a reference frame is moving observers within that frame must always judge light to move away from them at c, since the speed of light is taken to be a law of physics. So even if the reference frame was moving at .5c, as long as it was moving inertially Einstein would say that observers within that frame would always judge light to move away from them at c in all directions.

In defense of this, a physicist would say something like the following: 'Light always propagates at c, not half of c, regardless of the observer's motion. So while we might expect the light to slow down for the observers in the direction of motion the principle of relativity would prohibit that.'

My response is that it is true that the light would not be measured to slow down for the observer, but that is not the right way of thinking about it. If you were going at half the speed of sound we would not say that the sound wave slowed down for you, we would say that you were going half of that speed. Saying that the difference between your speed and the speed of the wave is only half what it would be if you were stationary is not the same as saying that the sound waves slowed down. The wave always travels at the same speed regardless of whether the observer is stationary, moving along with it, or moving away from it. The key is simply recognizing that the observer has velocity as well rather than considering her to be at rest. Similarly, for a reference frame that was moving at .5c observers in that frame would know that the light is traveling at the speed of light (not half the speed of light), and that is what they would measure, but they would also be able to measure themselves as going half of the speed of light, and that is the part that is missed.

This is one of the real peculiarities of Einstein's theory. He is very strongly committed to the claim that observers in each reference frame could, and in fact must always consider themselves to be at rest, even if according to other frames of reference they are moving. This is because he thinks that motion is relative. Because Einstein did not think that there was any such thing as absolute motion or an absolute state of rest he seems to have thought that the principle of relativity required that the motion of all inertially moving reference frames be set to zero from the perspective of that frame. Observers in other frames of reference might measure that frame's velocity to be .5c, but it would vary from frame to frame depending on their own velocity. Einstein thinks that observers in each frame would consider their own velocity to be zero, and the other frames to be moving instead, which explains why he thinks that they would always measure light to be traveling at the same

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[4] It was actually Henri Poincaré who first discussed the principle of relativity in published work. In a book called *La science et l' hypotheses* written in 1902, Poincaré dedicated a whole chapter to it. He said: 'There is no absolute uniform motion, no physical experience can therefore detect any inertial motion (no force felt), there is no absolute time, saying that two events have the same duration is conventional, as well as saying they are simultaneous is purely conventional as they occur in different places.' One can see some very striking similarities here to the special theory of relativity. Einstein claimed that he was unaware of Poincaré's work in 1905, but that seems dubious. The more that one studies the history of relativity theory the harder it becomes to ignore the fact that Einstein obviously 'borrowed' (to be charitable) some key ideas from others without always citing his sources. Many have marveled at how he could have been so productive during that so-called 'miracle year' of 1905; maybe it has something to do with the fact that many of those ideas were not original with him. By the way, speaking of citing sources, I got most of this information at this website: http://everythingimportant.org/relativity/Poincare.htm

speed in all directions. Since there is no absolute state of rest that one could appeal to in order to settle the question he believes that it really does just depend upon your perspective.

One may have occasionally had a feeling somewhat like this while traveling in a car. If you did not know better you might think that the signs and everything else along the side of the road were flying past you at 60 mph (about 97 kmh) while you and the car are motionless. According to the theory of relativity, they actually are; that is an equally correct way of describing the motion as to say that the car is moving and those objects are stationary. One may be tempted to say that one description is correct and the other only appears to be so, but Einstein insists that both are equally correct and that there is no non-arbitrary way of choosing between them. For him there is no such thing as absolute motion, there is only relative motion, and relative motion could be described equally well from either point of view.

But that is where I disagree. No one really thinks (not for more than a second or two anyway) that the car they are riding in is actually stationary while everything else in the world is moving around them. It is extremely unlikely that those in a spaceship that was moving at half the speed of light would be unaware of their own motion, even if it was inertial. Not only would the ship's instruments inform them as to how fast they were going relative to the things around them, they would also have felt the acceleration to get up to speed even if they did not feel the motion once it became inertial. Unless they had been moving at that speed and in that same direction for their entire lives they would remember accelerating. Einstein treats inertial motion as though it is indistinguishable from being at rest, but there are some very clear differences that an observer would notice. When you are moving almost everything else rushes past you at roughly the same speed and in the same direction. I suppose you could say that everything else is moving and you are stationary, and that may seem correct to you if you are a frequent drug user, but it seems rather implausible otherwise. Would observers ever really think that was actually the case?

If all inertially moving reference frames must always consider themselves to be at rest then it seems to me that this would not just apply to light waves it would also mean that you would never be able to reach or exceed the speed of sound either (or seismic waves, or water waves, or any other kind of wave) from the perspective of your own reference frame because to you that frame's velocity would always be zero while the wave's speed is greater than zero.

I do not know whether there is an absolute state of rest or not, but why couldn't we just consider the universe as a whole to be a reference frame? We have no way of knowing whether the universe is moving relative to something else outside of it (if there is anything outside of it), but for us it does not really matter because all of the motion that we are aware of and referring to is contained within the universe. This would be like comparing the motion of objects that are contained within a moving reference body such as a train, or an automobile, or an airplane etc., to that 'rigid body of reference' (as Einstein called it), or the x, y, z coordinate planes associated with that body. If each reference frame is considered to be at rest then you could compare the motion of every object within that frame to the frame itself to get an equivalent of absolute motion for all the things within that frame. (One also could not say that the whole frame is moving instead of the object that one is comparing it to, or the observers, since the frame is taken to be at rest.) If you were flying in a commercial airplane you could compare the motion of a pen that one passenger was writing with to the motion of another passenger walking down the aisle, or to the motion of a flight attendant at the other end of the plane, which would be the relative motion between those objects, but you could also compare the motion of any of the three to the reference frame itself, and the frame's coordinate system, to get the motion of that object relative to the reference frame. If we do this with the universe we have something similar to Newton's absolute motion, at least relative to our universe. If we added a time element then we would have the 'spacetime' coordinates of general relativity but they would not be relative, or perhaps I should say that they would be relative to the reference body of the entire universe, which for us is equivalent to being absolute. Observers within the reference frame may perceive events differently than other observers do based upon their position or if they are moving relative to the frame and the other observers are not, but they would be able to tell when they are moving relative to the reference frame (since the frame's motion is zero, any motion that they experience is their motion) and they would need to account for that when interpreting their own perceptions. Whether an object and/or an observer changes position relative to the reference frame and its associated coordinate plane would be an objective fact regardless of how it is perceived.

Moreover, if we insist that c is the maximum velocity for objects then there would have to be an absolute state of rest. We may infer that if you were in a spaceship that was traveling at the speed of light the objects that were rushing past you at c would actually be in a state of absolute rest. Now I guess, to be fair, the theory does say that you cannot ever actually reach the speed of light, but suppose it was like absolute zero in that we will probably never be able to reach absolute zero, but we can come close to it. If you were traveling at .9999c then the objects that appeared to be flying past you at the highest speed would be closest to being in an absolute state of rest. One could at least estimate what the absolute state of rest would be, and even if we could not find it precisely we would know that it must exist. And, if all observers in every reference frame always measure the speed of light to be c regardless of their own motion, as the theory purports, then it seems to me that the speed of light would have to be considered absolute motion. Thus, there would have to be absolute motion and an absolute state of rest, at least relative to our universe.

To return to our prior example, those on board a spaceship moving at half the speed of light would know that light always moves at the speed of light, but they would also be able to measure how fast they were moving as well. This is a really important point because the only way that it could be true that light always moves away from the observers on board the ship at c in all directions is if they were completely at rest. If we acknowledge that they have a velocity of .5c then we would have to say that they would measure the light waves going in the opposite direction as moving away from them at 1.5c and the waves going in the same direction as moving away from them at .5c. Light always propagates at c, but that is not what this is measuring; it is a measurement of the difference between the observer's speed and c, not a measurement of the speed of light itself.

There is one distinction that I need to make. If that spaceship moving at .5c is emitting light then that light would move away from the point in space from which it was emitted at c in all directions. Light always expands from the source at the same rate in all directions, regardless of the speed of the emitter, so if the observer was positioned at that point in space from which it was emitted and did not move from that spot after it was emitted then of course that light would move away from them at c in all directions. But that is not what the light postulate is saying, or at least not all that it is saying. The light postulate claims that if the light source is the sun observers on board the spaceship will still measure the sun's light to be moving away from them at c in all directions even if they are moving away from the sun at .5c, and that is just not true.

We can think of light waves as a sphere that expands from the source at c in all directions in which it is not blocked. Suppose that we have a spaceship that is traveling at .999c and emitting a light signal. The observers in the ship would see the light waves expanding from the source at c, but since they are traveling at .999c, which almost matches the rate of expansion, they would see the light in the direction of their motion as moving away from them at .001c and 1.999c in the opposite direction. It would be no different than a jet that is close to going supersonic. The jet is moving at nearly the speed of sound. The speed of the sound wave is not affected by the motion of the plane, and it is true that the sound waves expand at the same rate in all directions, but that does not mean that the sound waves move away from the pilot at the speed of sound because that would ignore the plane's motion. To figure out how fast the sound waves are moving away from the pilot in the direction of his motion you take the pilot's velocity and subtract that from the speed of the wave.

I doubt that anyone would seriously argue that the actual pitch of the sound being emitted by a siren is relative when we talk about the Doppler effect. Yet that is exactly the pattern of reasoning that is used in relativity theory. One could make a relativity-like argument to say that the Doppler effect is an accurate perception from that perceiver's frame of reference: the principle of relativity would commit us to saying that perceptions from all reference frames are equally correct, so you could argue that what one hears when a police car or ambulance goes by with its siren on is just as accurate from the perspective of that reference frame as the perception of what the siren sounds like from inside the emergency vehicle. Who is right about whether the pitch changes or not? The principle of relativity says both are. I will grant that it is not a misperception by either party; other listeners would hear the same thing from that vantage point, so in that sense it is accurate, but come on, we all know that the sound the siren is emitting does not really change in pitch; if there was any doubt of that we could rely on the testimony of those who were inside the emergency vehicle, who would report that it sounded the same to them throughout; yes, I know that they were in a different reference frame, but they were also the closest to the siren, so if the pitch really did change they should have been able to perceive it too. What is the justification to think that the perceptions of listeners in every reference frame are all equally correct in perceiving things as they really are? This is a fundamental assumption of relativity theory that is not justified. To believe that you must think that there are no observer-independent facts about the world, only perceptions, and all perceptions are equal. But if that is true then we ought to trust the perceptions of a schizophrenic as much as we trust the perceptions of a non-schizophrenic. (If there are no preferred reference frames then there could not be any preferred observers within a reference frame either.) Although a listener not moving with the siren may perceive the pitch to have changed, I say that the actual sound being produced by the siren does not change. The sound that is emitted is an independent fact that is not relative to the perceiver.

Summation

If you step outside of the current paradigm and really think about this objectively, which is the more plausible explanation of the phenomena, that the actual length of objects is contracted as they approach the completely non-special speed of electromagnetic waves, or that since we perceive things using those electromagnetic waves our perception of the object changes when it is moving at near the same speed? Is it more likely that time itself slows down for a reference frame simply because it happens to be traveling at a speed which is near the completely non-special speed of electromagnetic waves, or that the time it takes to perceive change to that reference frame is affected when it is traveling at a speed that is close to the speed of the electromagnetic waves that are used to perceive it? Ockham's razor is clearly in my favor on this one.

I am not really questioning the empirical data (at least most of it) as much as I am questioning how that data has been interpreted. But I know that scientists want experimental evidence, so here is how my theory could be tested. As previously described, I believe that time would only appear to slow down when the object in motion and/or the observer is moving away from the other. When the direction of motion is towards the observer (or the observer is moving towards the object, or both are moving towards each other) time will appear to speed up. If the spaceship giving the signals went right by the stationary ship at .5c the signal ship would appear to the observers on the stationary ship to be contracted in the direction of motion and time would appear to be running faster for it until it went past; then after it passed by the signal ship it would appear elongated and it would seem like time had slowed down for it. This is equivalent to the change in pitch that listeners hear when an emergency vehicle speeds past them.

For the theory of relativity direction does not matter. Einstein thinks that time dilation and length contraction are simply a function of speed, so whatever direction the object is traveling in observers in other reference frames should see time slow down for it and its length contracted in the direction its motion. It seems like it would not be too difficult to test these predictions. Perhaps an experimental physicist could devise an experiment to test it even now, if in fact they took my argument seriously enough to do so. If it is not possible right now, I would imagine that one day in the not-too-distant future it will become a testable prediction as technology continues to advance.